Global Scientific JOURNALS

GSJ: Volume 6, Issue 8, August 2018, Online: ISSN 2320-9186
www.globalscientificjournal.com

EFFECT OF GIBBERELLIC ACID ON YIELD AND YIELD ATTRIBUTES OF CANOLA (BRASSICA NAPUS L.) VARIETIES

Muhammad Rashid Nizamani[1,2*], Muhammad Ali Ansari[2], Mohammad Aquil Siddiqui[3], Ghulam Shah Nizamani[3], Faiza Nizamani[2], Misbah Naz[2], Abdul Hafeez Mastoi[4], Muhammad Amin Nizamani[5], Muhammad Asad Nizamani[6]

[1]College of Forestry, Northwest A&F University, Yangling, 712100, Shaanxi, China
[2]Faculty of Crop Production, Sindh Agriculture University, Tando Jam, 70050 Sindh, Pakistan
[3]Nuclear Institute of Agriculture, Tando Jam, 70050 Sindh, Pakistan
[4]Dept: of Entomology, Faculty of Agriculture, Lasbela University of Agriculture Uthal, Pakistan
[5]Department of Veterinary Pathology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tando Jam 70050 Sindh, Pakistan
[6]Information Technology Centre, Sindh Agriculture University Tando Jam 70050 Sindh, Pakistan
***** *Corresponding author: mrnizamani@gmail.com*

ABSTRACT: Gibberellic acid (GA_3) is a phytohormone that is needed in small quantities at low concentration to accelerate plant growth and development. So, the favorable condition may be induced by applying growth regulators exogenously in proper concentration at a proper time in a specific crop by GA_3. Gibberellic acid is such a plant growth regulator, which can manipulate a variety of growth and development phenomena in various crops. GA_3 enhances growth activities to plant, stimulates stem elongation. The early days to flowering, plant height, the number of branches plant^{-1}, *siliqua* plant^{-1}, siliqua length, seed siliqua^{-1}, 1000 seeds, seed yield and oil content under the concentration of GA_3 10 g ha^{-1}, while days to maturity and number of branches^{-1} were observed under the concentration of GA_3 5 g ha^{-1}. The maximum plant height and oil

ISSN 2320-9186

content in Con-II, number of branches in Oscar, siliqua plant^{-1} in Dunckled, siliqua length and 1000 seed in Abasin, seeds siliqua and seed yield were observed in Rainbow. The interaction of varieties and concentrations indicated that maximum plant height and siliqua plant under concentration of 10 g ha^{-1} GA_3, number of branches plant^{-1} under the concentration of 20 g ha^{-1} GA_3 in Dunckled, siliqua length, seed siliqua^{-1}, 1000 seed, seed yield and oil content were observed under concentration of 10 g ha^{-1} GA_3. The present results concluded that Rainbow, Dunckled, Con-II, and Oscar under the concentration of 10 g ha^{-1} GA_3 found the best concentration for yield and yield attributes of canola.

Key words: Canola, varieties, Gibberellic acid, yield attributes

1. INTRODUCTION

Agriculture is the mainstay of Pakistan's economy and majority of the population is directly or indirectly dependent on this sector. Although some advancement has been made in agriculture, like self-sufficiency in wheat and cotton in particular, still there exists chronic shortage of a very important constituent of human diet i.e. edible oil has persisted unabated for the last two decades. Thus, country is constrained to impart edible oil in large quantities. Thus, country is constrained to impart edible oil in large quantities (Mumtaz *et al*. 2001). The genus *Brassica* L. holds the most economically valuable position in the tribe *Brassicaceae*, which is a part of family *Brassicaceae* (Bilal *et al*. 2015). The species of genus *Brassica* are generally classified into two main groups commonly known as rapeseed and mustard. It also contains six economically valuable species with huge genetic and morphological variation and is cultivated in all over the world (Shah *et al.*, 2008).

In Pakistan the major oilseed crops grown in the country include Sunflower, Canola, Rapeseed & Mustard and Cotton. During 2013-14 total availability of edible oil was 3.20 million tons. Local production of edible oil contributed 0.573 million tons while import

ISSN 2320-9186

of edible oil/oilseeds was 2.627 million tons. The edible oil import bill during 2013-14 was Rs. 246.895 billion (US$ 2.50 billion). GPD (2015-16). Pakistan is deficient in the production of edible oils. Around 77% of total edible oils needs are met through imports at a cost of $1,054.7 million. Import bill of Pakistan is continuously the second largest after petroleum and constitutes the single largest expenditure on any of the imported food items (Ahmad *et al.*, 2013), so it is imperative to develop improved varieties of oilseed *Brassica* (Khatri *et al.*, 2005) and bring more area under cultivation of these. Plant growth regulators such as manipulating plant developments, enhancing yield and quality have been actualized new emerging and efficient plant growth regulators. Plant hormones including auxins, gibberellic acid, cytokinin, abscisic acid and ethylene are involved in controlling developmental events such as cell division, cell elongation and protein synthesis. The gibberellins stimulate cell division as well as cell elongation. Cytokinins regulate cell division in shoots and roots, modify apical dominance and promote lateral bud growth, assists in the movement of nutrients, stimulate seed germination, and delay leaf senescence. Gibberellins also cause pollen development as well as pollen tube growth, fruit growth, seed development and germination (Whitehead, 2008). The gibberellic acid (GA_3) has potential to enhance growth, flowering, photosynthesis, nutrient transport and yielding ability of mustard (Khan *et al.* 2005). So keeping in view the yield potential of cultivars, the present study was conducted on yield and yield components in *Brassica* varieties.

ISSN 2320-9186

2. MATERIALS AND METHODS

The experiment was conducted different *Brassica* varieties at Nuclear Institute of Agriculture, Tando Jam during 2015-16. The experiment was laid out in randomized complete block design (RCBD) with three replications. The treatment comprised ten varieties and five concentration of gibberellic acid, the main plot were genotypes while gibberellic acid concentrations were sub plots and consists of five-meter long five rows with 30 cm row to row distance. The ten *Brassica* varieties viz. Abasin-95, Con-I, Con-II, Con-III, Dunckled, Hyola-42, Oscar, Rainbow, Shiralee and Westar along with different concentration of gibberellic acid control, 5, 10, 15 and 20 g ha^{-1} were used in this study. The basal dose rate of NPK fertilizers at the rate of 90-60-00 kg ha^{-1} was applied in the form of urea and Di-ammonium phosphate respectively. These concentrations of GA_3 were sprayed on canopy as foliar spray method after 30 days after sowing. Ten plants were randomly selected from each treatment to record the data on yield and yield components from three central rows were harvested to estimate yield per unit area. Data were collected on germination percentage, days to flowering, days to maturity, plant height (cm), branches $plant^{-1}$, siliqua $plant^{-1}$, siliqua length (cm), seeds siliqua $^{-1}$, 1000 seeds weight (g), seed yield (kg ha^{-1}) and oil content (%). The experimental data were recorded and statistically analyzed through Statistix 8.1 computer software. The means were separated using LSD test ($P<0.05$) (Gomez and Gomez, 1984).

ISSN 2320-9186

3. RESULTS AND DISCUSSIONS

3.1 Days to flowering:

The effect of varieties, concentrations were highly significant, while their interactions were non-significant and are presented Appendix-I (Table 1). The results indicated those early days to flowering (75.90) under concentration of 10 g ha^{-1}, (71.40) in Oscar variety. The early days to flowering (69.00) in Con-III, followed by (69.66) in Oscar under concentration of GA_3 10 g ha^{-1}. The interaction of varieties and concentrations showed that early days to heading was observed (69.00) in Con-III under the concentration of 10 g ha^{-1} GA_3. The gibberellic acid promotes early flowering in *Brassica napus* and the results supported by Timothy (2000).

Table 1. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on days to flowering

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	80.66 g-l	81.00 f-k	79.00 lm	81.66 d-i	84.00 ab	81.26 b
Con-I	84.33 a	83.66 a-c	79.66 j-m	83.33 a-d	84.00 ab	83.00 a
Con-II	84.33 a	83.00 a-e	79.00 lm	84.00 ab	82.00 c-h	82.46 a
Con-III	71.00 s-u	73.00 qr	69.00 v	72.66 q-s	75.33 op	72.20 de
Dunckled	82.66 a-f	82.00 c-h	79.66 j-m	84.00 ab	83.33 a-d	82.33 a
Hyola-42	79.33 k-m	81.00 f-k	78.00 mn	81.33 e-j	83.00 a-e	80.53 b
Oscar	71.00 s-u	73.00 qr	69.66 uv	72.00 q-t	71.33 r-u	71.40 e
Rainbow	73.00 qr	73.33 q	70.33 t-v	73.66 pq	73.33 q	72.73 d
Shiralee	79.00 lm	80.33 h-l	76.66 no	80.00 i-l	81.66 d-i	79.53 c
Westar	81.66 d-i	82.33 b-g	78.00 mn	82.33 b-g	82.33 b-g	81.33 b
Mean	78.70 c	79.26 bc	75.90 d	79.50 ab	80.03 a	
Varieties SE (0.4215), LSD (5%) (0.8364), Concentrations SE (0.2980), LSD (5%) (0.5914), V x C SE (0.9424), LSD (5%) (-) cv. 1.47						

3.2 Days to maturity:

The effect of varieties, concentrations and their interactions were highly significant and are presented Appendix-I, (Table 2). The results indicated that early days to maturity was

ISSN 2320-9186

recorded (133.77) under concentration of 5 g ha^{-1} GA_3, early days to maturity (121.20) in Con-III, followed by (128.53) in Rainbow variety. The interaction of varieties and concentrations showed that early days to maturity was observed (120.00) in Con-III under concentrations of 5 and 10 g ha^{-1} GA_3. The results supported for *Brassica napus* varieties by Iqbal *et al*, (2008).

Table 2. Interactive effect of varieties × different concentrations of gibberellic acid on days to maturity

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	138.33 c-h	137.33 e-k	134.67 h-n	137.33 e-k	137.67 d-j	137.07 b
Con-I	135.00 h-m	135.33 g-m	132.00 m-q	136.00 f-l	137.67 d-j	135.20 cd
Con-II	133.67 k-o	134.00 j-n	138.00 c-i	138.00 c-i	137.00 e-k	136.13 bc
Con-III	124.33 tu	120.67 uv	120.00 v	120.00 v	121.00 uv	121.20 f
Dunckled	130.00 o-r	134.33 i-n	134.67 h-n	137.33 e-k	135.67 f-m	134.40 cd
Hyola-42	139.33 c-f	139.33 c-f	140.33 a-e	141.67 a-c	143.67 ab	140.87 a
Oscar	134.67 h-n	133.67 k-o	136.00 f-l	131.00 n-r	134.00 j-n	133.87 d
Rainbow	128.00 r-t	128.33 q-s	125.00 st	129.00 p-r	132.33 l-p	128.53 e
Shiralee	135.67 f-m	134.67 h-n	137.67 d-j	132.00 m-q	132.00 m-q	134.40 cd
Westar	139.00 c-g	140.00 b-e	141.67 a-c	141.33 a-d	144.00 a	141.20 a
Mean	133.80 b	133.77 b	134.00 b	134.37 ab	135.50 a	
Varieties SE (0.8904), LSD (5%) (1.7669), Concentrations SE (0.6296), LSD (5%) (1.2494), V x C SE (1.9909), LSD (5%) (3.9508) cv. 1.82						

3.3 Plant height (cm):

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-I (Table 3). The results indicated that maximum plant height was observed (161.47 cm) under concentration of 10 g ha^{-1}, (168.47 cm) in Con-II, followed by (161.53 cm) variety. The interaction of varieties and concentrations indicated that maximum plant height was obtained (173.33 cm) in Con-II, followed by (168.67 cm)

under the concentration of 10 g ha^{-1} GA_3 and minimum plant height (142.00 cm) was achieved in Abasin-95 under control. The results supported by Ali *et al,* (2002), Qayyum and Kakai (1999) for plant height among *Brassica* varieties.

Table 3. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on plant height (cm)

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	142.00 u	145.67 tu	147.33 st	151.33 p-s	148.33 r-t	146.93 g
Con-I	150.00 q-t	159.00 g-l	163.00 c-g	161.33 e-j	162.67 c-h	160.73 bc
Con-II	158.00 h-m	161.33 e-j	168.67 ab	156.00 k-p	159.67 e-k	168.47 a
Con-III	166.67 bc	166.33 b-d	173.33 a	164.00 b-f	172.00 a	158.87 cd
Dunckled	156.67 j-o	156.67 j-o	162.67 c-h	157.00 i-n	161.33 e-j	152.33 f
Hyola-42	156.67 j-o	148.00 r-t	154.67 l-q	148.67 r-t	153.67 m-q	156.53 e
Oscar	152.67 n-r	151.67 p-s	160.33 e-k	157.00 i-n	161.00 e-j	155.40 e
Rainbow	147.67 st	154.67 l-q	161.67 d-i	153.67 m-q	159.33 f-l	161.53 b
Shiralee	158.33 g-m	160.67 e-k	167.00 bc	160.00 e-k	161.67 d-i	157.00 de
Westar	152.00 o-s	152.00 o-s	156.00 k-p	160.67 e-k	164.33 b-e	159.20 cd
Mean	154.07 c	155.60 bc	161.47 a	156.97 b	160.40 a	
Varieties SE (1.1224), LSD (5%) (2.2273), Concentrations SE (0.7936), LSD (5%) (1.5750), V x C SE (2.5097), LSD (5%) (4.9805) cv. 1.95						

3.4 Number of branches $plant^{-1}$:

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-I (Table 4). The results indicated for concentration that maximum number of branches $plant^{-1}$ was observed (3.73) under concentration of 5 g ha^{-1} GA_3, the mean of varieties showed that maximum number of branches plant (4.46) in Oscar, followed by (4.40) in Rainbow variety. The interaction of varieties and

concentrations showed that maximum number of branches plant^{-1} (5.34) in Dunckled under the concentration of 20 g ha^{-1} GA_3, (5.34) in Rainbow under the concentration of 5 g ha^{-1} GA_3 , followed by number of branches plant^{-1} (5.01) was observed in Rainbow under the concentration of 5 g ha^{-1} GA_3. The results were in contrast to our results for branches plant^{-1} as observed significant differences and supported by Zebarjadi *et al*, (2011).

Table 4. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on number of branches plant^{-1}

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	4.33 a-d	3.33 b-g	4.00 a-e	2.67 d-i	4.00 a-e	3.66 a-c
Con-I	3.66 a-f	4.67 a-c	4.00 a-e	3.33 b-g	5.33 a	4.20 ab
Con-II	3.33 b-g	4.00 a-e	3.66 a-f	4.00 a-e	2.66 d-i	3.53 bc
Con-III	3.66 a-f	4.66 a-c	4.01 a-e	4.33 a-d	4.33 a-d	4.20 ab
Dunckled	3.00 c-h	3.67 a-f	4.67 a-c	5.00 ab	5.34 a	4.33 ab
Hyola-42	3.33 b-g	1.00 i	2.00 f-i	1.33 hi	1.33 hi	1.80 d
Oscar	4.66 a-c	5.00 ab	4.33 a-d	4.00 a-e	4.33 a-d	4.46 a
Rainbow	5.34 a	5.01 ab	4.67 a-c	4.33 a-d	2.67 d-i	4.40 ab
Shiralee	4.66 a-c	4.33 a-d	2.66 d-i	3.67 a-f	1.00 i	3.26 c
Westar	3.67 a-f	1.66 g-i	2.33 e-i	2.00 f-i	1.00 i	2.13 d
Mean	3.96 a	3.73 ab	3.63 ab	3.46 ab	3.20 b	
Varieties SE (0.4426), LSD (5%) (0.8783), Concentrations SE (0.3130), LSD (5%) (0.6211), V x C SE (0.9897), LSD (5%) (1.9640) cv. 3.67						

3.5 Siliqua plant^{-1}:

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-I, (Table 5). The results indicated that maximum siliqua plant^{-1} was observed (126.27) under the concentration of 10 g ha^{-1} of GA_3, the mean of varieties indicated that maximum siliqua plant^{-1} was observed (124.33) in Dunckled, followed by (122.87) in Abasin. The interaction of varieties x concentration showed that maximum siliqua plant^{-1} were recorded in Con-II (138.67), followed by (138.00) Dunckled under the concentration of 10 g ha^{-1} of GA_3 and minimum (79.67) was achieved (79.67) in Con-III under control. The result of the present study is similar to the findings

ISSN 2320-9186

of Khan *et al.* (1998) who observed that application of GA_3 on *Brassica napus* had increased the number of siliqua plant^{-1}. GA_3 might have increased the translocation of assimilates to the reproductive organ which resulted in the maximum number of siliqua plant^{-1} up to certain levels of GA_3 application (Uddin *et al.,* 1986; Kandil, 1983).

Table 5. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on siliqua plant^{-1}

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	125.33 c-f	116.00 h-l	131.33 bc	120.67 d-j	121.00 d-j	122.87 a
Con-I	107.33 n-p	98.67 q-s	106.67 op	88.00 t-v	92.67 st	98.67 d
Con-II	117.67 g-k	121.67 d-i	138.67 a	106.33 op	95.00 r-t	115.87 b
Con-III	79.67 w	92.67 st	110.67 k-o	81.67 u-w	81.00 vw	89.13 e
Dunckled	131.33 bc	120.33 e-j	138.00 ab	114.00 j-n	118.00 g-j	124.33 a
Hyola-42	120.67 d-j	118.00 g-j	127.67 cd	115.33 i-m	99.00 q-s	116.13 b
Oscar	122.67 d-h	117.00 g-k	123.33 d-g	116.33 g-k	105.33 o-q	116.93 b
Rainbow	127.33 c-e	126.33 c-f	135.33 ab	117.67 g-k	101.67 p-r	121.67 a
Shiralee	117.67 g-k	95.00 r-t	131.67 a-c	109.00 l-o	95.67 rs	109.80 c
Westar	101.67 p-r	88.33 tu	119.33 f-j	108.67 m-p	88.33 tu	101.27 d
Mean	115.13 b	109.40 c	126.27 a	107.77 c	99.77 d	
Varieties SE (1.5944), LSD (5%) (3.1641), Concentrations SE (1.1274), LSD (5%) (2.2373), V x C SE (3.5652), LSD (5%) (7.0751) cv. 3.91						

3.6 Siliqua length (cm):

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-II (Table 6). The results indicated for different concentrations showed that maximum siliqua length was observed (4.91 cm) under concentration of 10 g ha^{-1} GA_3, the mean of varieties showed that maximum siliqua length (4.97 cm) in Abasin-95 variety, followed by (4.83) in Rainbow and minimum (3.92) were recorded in Con-I. The interaction of varieties and concentrations showed that maximum siliqua length (5.56 cm) in Rainbow, followed by (5.43) in Abasin under the concentration of 10 g ha^{-1} GA_3. Our results for siliqua length supported up to certain levels of GA_3 application by the findings of Zebarjadi *et al*, (2011).

ISSN 2320-9186

Table 6. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on siliqua length (cm)

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	5.10 a-e	5.00 b-f	5.43 ab	4.33 g-o	5.00 b-f	4.97 a
Con-I	3.43 tu	4.23 h-q	5.20 a-d	3.33 u	3.43 tu	3.92 e
Con-II	4.60 f-k	4.16 j-r	4.53 f-l	3.80 p-u	3.33 u	4.08 de
Con-III	4.10 l-r	4.16 j-r	4.70 e-h	3.86 o-t	3.50 tu	4.06 e
Dunckled	4.93 c-f	4.53 f-l	5.30 a-c	4.63 e-j	4.03 m-s	4.68 b
Hyola-42	4.16 j-r	4.06 l-s	4.53 f-l	3.60 s-u	3.76 q-u	4.02 e
Oscar	4.10 l-r	3.90 n-t	4.40 g-m	3.70 r-u	4.03 m-s	4.02 e
Rainbow	5.20 a-d	4.90 c-f	5.56 a	4.36 g-n	4.13 k-r	4.83 ab
Shiralee	4.66 e-i	4.36 g-n	4.70 e-h	4.20 i-q	4.03 m-s	4.39 c
Westar	4.26 h-p	4.30 g-o	4.76 d-g	4.16 j-r	4.00 m-s	4.30 cd
Mean	4.45 b	4.36 b	4.91 a	4.00 c	3.92 c	
Varieties SE (0.1076), LSD (5%) (0.2136), Concentrations SE (0.761), LSD (5%) (1.1510), V x C SE (0.2406), LSD (5%) (0.4775) cv. 6.80						

3.7 Seeds $siliqua^{-1}$:

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-II, (Table 7). The results indicated that maximum seeds $siliqua^{-1}$ was observed (14.13) under concentration of 10 g ha^{-1} GA_3, the mean of varieties indicated that maximum seeds siliqua (13.40, 13.00 and 12.00) were observed in Rainbow, Hyola-42 and Shiralee respectively. The interaction of varieties and concentrations showed that maximum seeds siliqua (17.00) was observed in Rainbow variety, followed by (15.00) in Con-I, Hyola-42 and Shiralee for seeds $siliqua^{-1}$ under the concentration of 10 g ha^{-1} GA_3. The minimum seeds $siliqua^{-1}$ was observed (8.00) in Abasin-95 under the concentration of 20 g ha^{-1}. The results supported by (Boultior and Morgan, 1992) that plant growth regulators like GA_3 might be involved in formation of seeds in the siliqua and their optimum nourishments have resulted in less number of aborted seeds and thus maximized the survival of seeds $siliqua^{-1}$ in rapes and mustard.

ISSN 2320-9186

Table 7. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on seeds siliqua^{-1}

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	10.33 g-m	8.66 l-n	14.00 bc	9.33 j-n	8.00 n	10.06 d
Con-I	12.00 c-h	10.00 h-n	15.00 ab	11.66 d-i	10.00 h-n	11.73 b
Con-II	11.00 f-k	10.00 h-n	12.00 c-h	10.00 h-n	10.00 h-n	10.60 cd
Con-III	12.33 c-g	11.00 f-k	13.66 b-d	11.33 e-j	11.33 e-j	11.93 b
Dunckled	10.33 g-m	9.33 j-n	14.00 bc	9.66 i-n	8.33 mn	10.33 d
Hyola-42	13.00 b-f	13.33 b-e	15.00 ab	12.00 c-h	11.66 d-i	13.00 a
Oscar	12.00 c-h	12.33 c-g	14.00 bc	10.66 g-l	9.66 i-n	11.73 b
Rainbow	14.00 bc	15.00 ab	17.00 a	12.00 c-h	9.00 k-n	13.40 a
Shiralee	11.00 f-k	12.00 c-h	15.00 ab	10.33 g-m	11.66 d-i	12.00 b
Westar	12.00 c-h	13.00 b-f	11.66 d-i	11.33 e-j	9.00 k-n	11.40 bc
Mean	11.80 b	11.46 bc	14.13 a	10.83 c	9.86 d	
Varieties SE (0.4793), LSD (5%) (0.9511), Concentrations SE (0.3389), LSD (5%) (0.6725), V x C SE (1.0717), LSD (5%) (2.1267) cv. 11.30						

3.8 1000 seeds (g):

The effect of varieties, concentrations and their interactions were highly significant and are presented Appendix-II, (Table 8). The results indicated that maximum 1000 seeds was observed (5.05 g) under the concentration of 10 g ha^{-1} GA_3, the mean of varieties indicated that maximum 1000 seeds (5.36 g) in Rainbow, followed by (4.92 g) in Abasin and minimum 1000 seeds (3.77 g) were obtained in Wester variety. The interaction of varieties and concentrations showed that maximum 1000 seeds was observed (6.03 and 5.43 g) in Rainbow and Abasin varieties under the concentration of 10 g ha^{-1} GA_3 and minimum was observed in Westar (3.60 g) under concentration of 20 g ha^{-1} GA_3. Our highly significant results for 1000 seeds were also supported by the earlier results of Zebarjadi *et al*., 2011.

ISSN 2320-9186

Table 8. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on 1000 seeds weight (g)

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	5.10 c-e	4.90 e-h	5.43 b	4.70 f-k	4.50 j-o	4.92 b
Con-I	4.10 rs	4.23 n-s	4.70 f-k	4.13 q-s	4.16 p-s	4.26 e
Con-II	4.83 e-i	4.53 i-n	5.33 bc	4.40 k-r	4.06 st	4.63 c
Con-III	4.23 n-s	4.20 o-s	4.83 e-i	4.20 o-s	4.20 o-s	4.33 de
Dunckled	4.46 j-p	4.60 h-m	5.10 c-e	4.66 g-l	4.20 o-s	4.60 c
Hyola-42	4.10 rs	4.26 n-s	5.26 b-d	4.13 q-s	4.36 l-s	4.42 d
Oscar	4.30 m-s	4.43 k-q	5.00 d-f	4.36 l-s	4.10 rs	4.44 d
Rainbow	5.10 c-e	5.50 b	6.03 a	5.23 b-d	4.96 d-g	5.36 a
Shiralee	4.40 k-r	4.16 p-s	4.76 f-j	4.23 n-s	4.30 m-s	4.37 de
Westar	3.76 tu	3.77 tu	4.10 rs	3.63 u	3.60 u	3.77 f
Mean	4.44 b	4.46 b	5.05 a	4.37 b	4.24 c	
Varieties SE (0.0694), LSD (5%) (0.1378), Concentrations SE (0.0491), LSD (5%) (0.0974), V x C SE (0.1552), LSD (5%) (0.3081) cv. 4.21						

3.9 Seed yield (kg ha^{-1}):

The effect of varieties, concentrations were highly significant, while their interactions were non-significant and data are presented Appendix-II (Table 9). The results indicated that maximum seed yield was observed (1665.6 kg ha^{-1}) under the concentration 10 g ha^{-1} of GA_3, the mean of varieties showed that maximum seed yield were achieved (1845.3 kg ha^{-1}) in Rainbow, followed by (1764.7 kg ha^{-1}) and minimum (1370.3 kg ha^{-1}) in Wester. The interaction of varieties and concentration showed that maximum seed yield was observed (1926.0 and 1846.7 kg ha^{-1}) in Rainbow under the concentration 10 and 15 g ha^{-1} of GA_3 and minimum (1325.0 kg ha^{-1}) was observed in Wester. The results agreed with Khan *et al.* (2002) that GA3 enhanced seed yield of *Brassica napus.* Hayat *et al*. (2001) also conducted an experiment with GA_3 foliar spray after 30 days of planting in *Brassica napus* and observed that GA_3 increased vegetative growth and seed yield at harvesting time up to a certain limit. The results also supported by Deotale *et al*, 1998.

ISSN 2320-9186

Table 9. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on seed yield (kg ha^{-1})

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	1451.7 m-q	1495.0 k-q	1538.3 h-q	1444.7 m-q	1473.7 l-q	1480.7 ef
Con-I	1544.3 g-q	1569.3 e-p	1613.7 c-n	1553.0 f-q	1520.3 i-q	1560.1 de
Con-II	1578.3 d-o	1629.7 b-n	1658.7 b-m	1628.3 b-n	1606.7 c-n	1620.3 cd
Con-III	1626.0 b-n	1655.7 b-m	1692.0 b-l	1634.3 b-n	1622.3 b-n	1646.1 cd
Dunckled	1639.3 b-n	1687.3 b-l	1708.7 a-k	1653.7 b-m	1743.7 a-i	1686.5 bc
Hyola-42	1703.0 a-l	1726.7 a-j	1755.7 a-h	1706.3 a-k	1122.6 r	1602.8 cd
Oscar	1723.3 a-k	1770.0 a-g	1800.0 a-d	1780.7 a-f	1749.7 a-i	1764.7 ab
Rainbow	1798.7 a-e	1829.0 a-c	1926.0 a	1846.7 ab	1826.0 a-c	1845.3 a
Shiralee	1352.3 o-q	1376.7 o-q	1511.0 j-q	1411.3 n-q	1341.7 p-r	1398.6 fg
Westar	1339.3 qr	1360.7 o-q	1452.0 m-q	1374.3 o-q	1325.0 qr	1370.3 g
Mean	1575.6 bc	1610.0 ab	1665.6 a	1603.3 a-c	1533.2 c	
Varieties SE (51.72), LSD (5%) (102.64), Concentrations SE (36.57), LSD (5%) (72.58), V x C SE (115.66), LSD (5%) (229.52) cv. 8.87						

3.10 Oil content (%):

The effect of varieties, concentrations and their interactions were highly significant and data are presented Appendix-II (Table 10). The results indicated that maximum oil content was observed (43.38 %) under concentration of 10 g ha^{-1} GA_3, mean of indicated that maximum oil content (42.83) observed in Rainbow variety, followed by (42.66 %) in Con-II and minimum oil content was observed (39.50 %) in Wester variety. The interaction of varieties and concentrations showed that maximum oil content was observed (45.16 %) in Rainbow, followed by (45.01 %) in Dunckled under the concentration of 10 g ha^{-1} and minimum oil content was observed in Shiralee (38.49 %)

ISSN 2320-9186

under concentration of 20 g ha^{-1} GA_3. The results agreed with Aytac and Kinaci (2009) for oil content among *Brassica* varieties.

Table 10. Interactive effect of *Brassica napus* varieties × different concentrations of gibberellic acid on oil content (%)

Varieties	Gibberellic acid					Mean
	Control	5 g ha^{-1}	10 g ha^{-1}	15 g ha^{-1}	20 g ha^{-1}	
Abasin-95	41.34 f-i	39.66 j-m	43.01 c-e	40.34 h-k	39.33 k-m	40.73 c-e
Con -I	42.34 d-g	39.67 j-m	42.51 d-f	40.17 i-k	39.50 k-m	40.83 cd
Con-II	42.66 d-f	42.33 d-g	45.00 a	43.17 b-d	40.17 i-k	42.66 ab
Con-III	39.16 k-m	40.16 i-k	43.16 b-d	41.01 g-j	39.49 k-m	40.60 d-f
Dunckled	43.00 c-e	41.01 g-j	45.01 a	41.67 e-h	39.49 k-m	42.03 b
Hyola-42	40.33 h-k	39.48 k-m	42.33 d-g	40.01 i-l	38.50 m	40.13 e-g
Oscar	39.67 j-m	41.00 g-j	44.50 ab	41.66 e-h	40.00 i-l	41.36 c
Rainbow	44.16 a-c	42.50 d-f	45.16 a	41.00 g-j	41.33 f-i	42.83 a
Shiralee	39.48 k-m	39.66 j-m	42.16 d-g	40.15 i-k	38.49 m	40.00 fg
Westar	38.66 lm	39.83 j-m	41.02 g-j	38.50 m	39.50 k-m	39.50 g
Mean	41.08 b	40.53 c	43.38 a	40.76 bc	39.58 d	
Varieties SE (0.3231), LSD (5%) (0.6412), Concentrations SE (0.2285), LSD (5%) (0.4534), V x C SE (0.7225), LSD (5%) (1.4338) cv. 2.15						

Appendix I. Interactive effect of *Brassica napus* varieties x different concentrations of gibberellic acid

Source	DF	Days to flowering (days)	Days to maturity (days)	Plant height (cm)	Branches $plant^{-1}$	Sliqua $plant^{-1}$
Replications	2	0.720ns	11.007	13.040	1.3400	19.09
Varieties	9	324.323**	512.712**	492.152**	13.6000**	2066.01**
Concentrations	4	79.327**	15.510**	297.200**	2.4833*	2903.52**
V x C	36	2.512ns	13.154**	30.815**	2.3056**	142.68**
Error	98	1.332	5.945	9.448	1.4693	19.07
CV%		1.47	1.82	1.95	3.67	3.91

ns= non-significant, *= significant, ** = highly significant at 5% level

ISSN 2320-9186

Appendix II. Interactive effect of *Brassica napus* varieties x different concentrations of gibberellic acid

Source	**DF**	Sliqua length (cm)	Seeds sliqua $^{-1}$	1000-seed weight (g)	Seed yield (kg ha^{-1})	Oil content (%)
Replications	2	0.00080	1.5800	0.00887	13140	0.3800
Varieties	9	2.12427**	17.4970**	2.65908**	344056**	19.2535**
Concentrations	4	4.71743**	75.4933**	2.96310**	70846**	59.5642**
V x C	36	0.21069**	3.4970**	0.07899**	21781ns	2.0549**
Error	98	0.08685	1.7229	0.03615	20065	0.7831
CV%		6.80	11.30	4.21		2.15

ns= non-significant, *= significant, ** = highly significant at 5% level

Conclusion

It is concluded that *Brassica napus* varieties should be sown at Tando Jam, Sindh, Pakistan location with the foliar spray of GA_3 under the concentration of 10g ha^{-1} to achieve beneficial results for yield and yield attributes of canola.

ISSN 2320-9186

REFERENCES:

Ahmad B, Mohammad S, Azam F, Ali I, Ali J, Rehman SU (2013). Studies of genetic variability, heritability and phenotypic correlations of some qualitative traits in advance mutant lines of winter rapeseed (*Brassica napus* L.). Am Eur J Agri Environ Sci 13: 531-538.

Ali N, Javidfar F, Attary AA (2002). Genetic variability, correlation and path analysis of yield and its components in winter rapeseed *(Brassica napus* L.*).* Pak J Bot 34: 145-150.

Aytac Z, Kinaci G (2009). Genetic variability and association studies of some quantitative characters in winter rapeseed (*Brassica napus* L.*).* Afr J Biotech 8: 3547-3554.

Bilal MB, Sher AK, Haneef R, Farhad A, Shah MK, Naushad A, Izhar H, Junaid K (2015). Evaluation of some indigenous rapeseed genotypes for adaptability and yield traits in the agro-climatic conditions of Mansehra. Int J Biosci 7: 127-135.

Boultior C, Morgan DG (1992). Development of oilseed rape buds, flowers and pods *in vitro*. J Expt Bot 43: 1089-1096.

Deotale RD, Mask VG, Sorte NV, Chimurkar BS, Yerne AZ (1998). Effect of GA_3 and IAA on morpho-physiological parameters of soybean. J Soils Crops 8: 91-94. (Cited from Field Crop Abst 1998 51:1114)

Gomez KA, Gomez AA (1984). Statistical Procedure for Agricultural Research, (2 eds.) P: 680 Wiley New York, USA.

GOP 2015-16. Economic Survey of Pakistan. Ministry of Food, Agriculture and Livestock, Govt of Pak, Statistics Division (Economic Wing), Islamabad, pp. 30-31.

ISSN 2320-9186

Hayat S, Ahmed A, Mobin M, Fariduddin Q, Azam ZM (2001) Carbonic anhydrase, photosynthesis and seed yield in mustard plants treated with phytohormones and Photosynthetia. 39:111-114. (Cited from Plant Growth Regulator Abst. 1995. 23(3): 208).

Iqbal M, Akhtar N, Zafar S, Ali I (2008). Genotypic responses for yield and seed oil quality of two *Brassica* species under semi-arid environmental conditions. South Afri J Bot 74: 567-571.

Kandil AA (1983). Effects of sowing date of yield and yield components and some agronomic characters of oilseed rape (*Brassica napus* L.). In: 6th Rapeseed Conf Paris France. pp. 297.

Khan NA, Ansari HR, Sanullah (1998). Effect of GA_3 spray during ontogeny of mustard on growth, nutrient uptake and yield characteristics. J Agro Crop Sci 181: 61-63.

Khan NA, Ansari HR, Khan M, Mir R, Sanuiullah (2002). Effect of phytohormones on growth and yield of Indian mustard. Ind J Plant Phys 7: 75-78.

Khan NA, Mobin M, Samiullah. 2005. The influence of gibberellic acid and sulfur fertilization rate on growth and S-use efficiency of mustard (*Brassica juncea*). Plant & Soil 270: 269-274.

Khatri A, Khan IA, Siddiqui MA, Raza S, Nizamani GS (2005). Evaluation of high yielding mutants of *(Brassica juncea* L.) cv. S-9 developed through Gamma rays and EMS. Pak J Bot 37: 279-2 84.

Mumtaz A, Cheema M, Asghar M, Basra SMA (2001). Comparative growth and yield performance of different *Brassica* varieties Int J Agri & Bio, 03: 135-137

Qayyum SM, Kakai A (1999). Influence of nitrogen level on growth and yield of rape grain (*Brassica napus* L.). Sindh Agri Uni Tando Jam, Pak 84: 432-436.

ISSN 2320-9186

Shah S, Molla MR, Chandra D, Rahman L (2008). Assessment of genetic variation and relationships within the varieties of four *Brassica* species by RAPD markers. Aus J Crop Sci 2: 105-114.

Timothy JPD (2000). The effect of Gibberellin A_3 on wild and dwarf *Brassica rapa* as studied under laboratory conditions, University of Notre Dame, Notre Dame, IN Bio Sci pp 1-11. http://timothyducey.files.wordpress.com

Uddin MM, Samad A, Khan MR, Begum S, Salam MA (1986). Effect of sowing dates on the yield and some of its components of mustard and rapeseed. Bang J Sci Ind Res 21: 160-165.

Whitehead, Alan (2008). The effects of gibberellic acid on wild type and Rosette Plants of the Species, *Brassica rapa*. University of Alabama at Birmingham. Lab Handout www.regional.org.au/au/gcirc/canola/p-07.htm#P698_75989

Zebarjadi A, Kakaei M, Mostafaie A (2011). Genetic variability of some traits in Rapeseed (*Brassica napus* L.) under drought stress and non-stress conditions. Biharean Biologist. 5: 127-131.