

CHANGES IN SEED YIELD OF SUNFLOWER (*Helianthus annuus* L.) IN RELATION TO THE SEED RATE AND METHOD OF SOWING

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Abstract

Inappropriate seed rate and sowing method contribute a significant role in low productivity of sunflowers. So, a study was conducted to assess the effect of different seed rates and sowing methods on the yield of sunflower in Ghodaghodi Municipality ward no. 2, Sandepani, far-west province, Kailali, Nepal, during spring season in 2018. The three different seed rates (8 Kg/ha, 10 Kg/ha and 12 Kg/ha) combined with three different sowing methods (broadcasting, line sowing and ridge sowing). A randomized complete block design in a 3×3 factorial arrangement with three replicates per treatment was applied. The indigenous variety of sunflower was used as a test crop. The highest stem diameter was recorded with the lowest seed rate, which remained unaffected by different sowing methods. Head diameter, seeds per head and thousand-grain weight were maximum in plants receiving seed rate of 8 kg/ha. However, the highest (2.13 t/ha) and the lowest (1.76 t/ha) grain yield were achieved with the seed rates of 10 kg/ha and 12 Kg/ha, respectively. Regarding sowing methods, head diameter, seeds per head, thousand-grain weight and grain yield (2.68 t/ha) obtained in the ridge method were statistically superior over those, obtained in line and broadcasting methods. The interaction effect of seed rate and sowing method on seeds per head suggested that maximum seeds per head were obtained with 8 kg/ha seed sown in the ridge. Our study recommended 8 kg/ha seed rate and ridge sowing of sunflower performed best in grain yield.

Keywords: Seed rate; Sowing method; Sunflower; Yield.

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1. Introduction

Sunflower (*Helianthus annuus L.*) occupies a prominent position among oilseed crops in the world because of its high-oil content (40-50%), high unsaturated fatty acids content (85-91%) and no cholesterol (Khalifa & Awad, 1997; Leland, 1996). Its oil is rich in vitamins K, E, D and A. Besides, seed cake is suitable for feeding material for animals and poultry, which contains protein (35%) and carbohydrates (18-20%) (Ibrahim, 2012). In the context of Nepal, the current figure of national productivity is 2.11 t/ha, which is low than potential yield (MOALC, 2016/17). Lacks of recommended variety as well as recommended dosage of fertilizer and skilled human resources are responsible for low productivity of it. Also, conventional farming practices like inappropriate seed rate, faulty method of sowing and lack of modern production technologies lead to low production.

The yield of sunflower is controlled by several factors, including plant population and sowing methods. Plant population per unit area determines the optimum above-ground conditions that allow the plant to acquire the essential growth elements (light, CO₂, etc.) that influence the productivity of dry matter and hence the final yield (Abou-Kresha et al., 1996). The number of heads per unit area increased, thus leading to a 23 % increase in seed yield when the plant population reached 100 thousand plants/ha (Esechie et al., 1996). In contrast, Mathers and Stewart (1982), El-Tabbakh (1994) and Rousseaux et al. (1999) reported that maximum seed yield was obtained with 60 thousand plants/ha. Gubbels (1989) and Sarmah et al. (1994) indicated that 40-50 thousand plants/ha gave the highest seed and oil yields per ha. Concerning the sowing method, Esechie et al. (1996) reported the highest yield from the ridge sown sunflower. It is also reported that seed yield was increased with graded ridges (Ahmad et al., 2000).

As plant population and sowing methods are major governing factors for the total yield of sunflower, this research would provide the appropriate method of cultivation to be applied as well as proper seed rate to be maintained. This study aimed to know the response of indigenous sunflower variety to various sowing methods with different seed rates for higher yield in the Kailali district of Nepal. We assumed that there would be no significant difference in the yield with different varying rates of seed and sowing methods.

2. Materials and Methods

2.1. Study area

The present investigation was conducted during spring season of 2018 in Ghodaghodi Municipality ward no. 2, Sandepani, Far-west province, Kailali, Nepal. The geographical location of the site is 28° 40'05.87" north latitude and 80° 59'13.04" east longitudinal (PMAMP, 2018). The maximum and minimum temperatures recorded during the study period were 35°C and 25°C, respectively. The soil on the experiment was sandy loam and acidic with a grayish color (PMAMP, 2018).

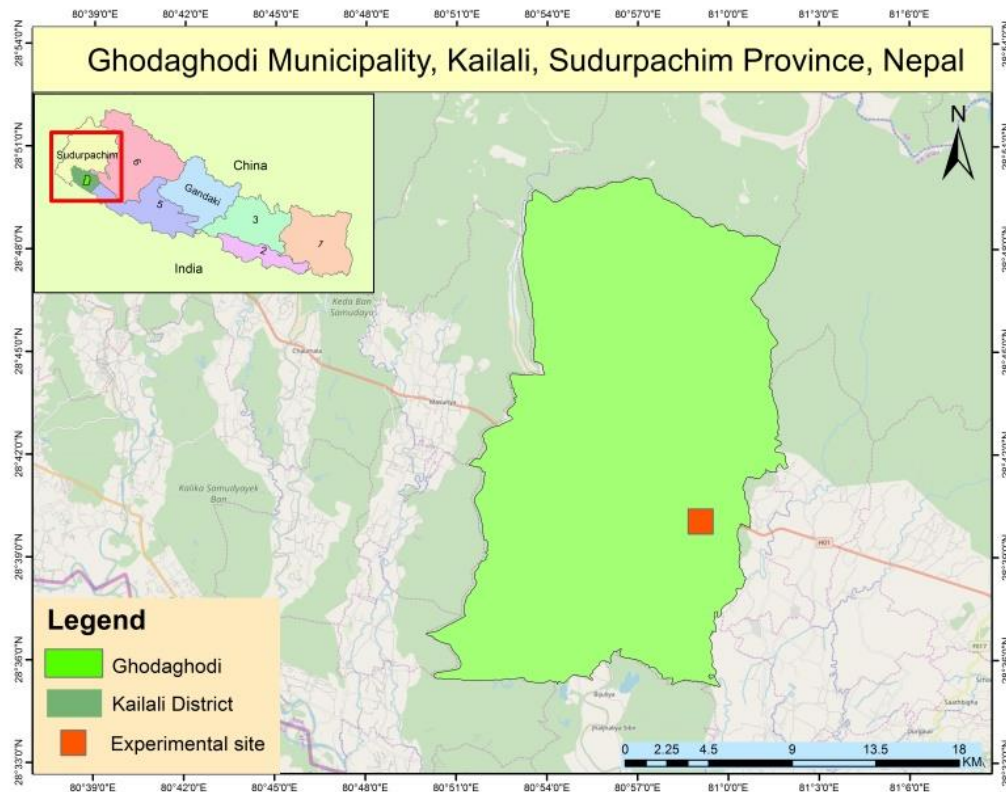


Figure 1: Location map of the study area

2.2. Treatment combination

The field experiment comprised 9 treatment combinations. There were three different levels of seed rate i.e., 8 Kg/ha (S1), 10 Kg/ha (S2) and 12 Kg/ha (S3). Similarly, Broadcasting (M1), Line sowing (M2) and Ridge sowing (M3) were methods of planting.

2.3. Plot size and Field layout

The experiment was laid out in 3×3 factorial Randomized Complete Block Design with three replications, making a total of 27 plots. The size of each plot was 6 m² with an alley of 30 cm. Each plot contained at least

32 plants and ten plants were randomly selected from each plot as sample plants for studying different parameters.

2.4. Statistical Analysis

The data obtained from the experimental plots were tabulated in Microsoft Excel. Duncan's Multiple Range Test (DMRT) was employed to find out the significant differences between the mean values at the 0.05 level of significance. The significance was also determined by using the ANOVA table. The GEN-STAT was used to find the coefficient of variance and the grand mean.

3. Results and Discussion

3.1. Plant Population

Application of seed rate had a significant effect on the plant population. As shown in Table 1, the number of plants was found higher in treatment S3 (96.78) at 20 days after sowing (DAS). This was followed by S2 (80.78) and then by S1 (60.78). Similarly, at 30 DAS, maximum and minimum plant population was found on S3 (111.22) and S1 (66.22), respectively. Also, at 40 DAS, the plant population of sunflower was maximum on S3 (111.22), followed by S2 (92) and then by S1 (66.11). Sowing methods had a non-significant effect on plant population. The possible reason might be that the seed has its own reserved food that helps in emergence without any role by the sowing methods. This result is in line with the finding of Ahmad et al. (2000), who noticed the non-significant effect of different sowing methods on emergence/m².

Table: 1 Effect of different seed rates and sowing methods on Plant population and Stem diameter.

Treatments	Plant Population				Stem Diameter (cm)	
	20 DAS	30 DAS	40 DAS	60 DAS	75 DAS	90 DAS
	Seed Rates					
S3	96.78 ^a	111.22 ^a	111.22 ^a	1.28 ^b	1.48 ^b	1.88 ^b
S2	80.78 ^b	91.78 ^b	92 ^b	1.31 ^b	2.00 ^a	2.3 ^a
S1	60.78 ^c	66.22 ^c	66.11 ^c	1.51 ^a	2.26 ^a	2.4 ^a
LSD _{0.05}	8.8***	6.19***	6.22***	0.1785*	0.269***	0.183***
	Sowing Methods					
M3	81.11	91.11	91.33	1.476	2.07	2.26
M2	79.22	89.78	89.22	1.34	1.92	2.12
M1	78	88.33	89.78	1.28	1.75	2.19
LSD _{0.05}	NS	NS	NS	NS	NS	NS

(Means followed by different letters within column are significantly different based on DMRT at P = 0.05; LSD = Least significant difference; NS = Non-significant; * and *** indicates level of significance at 5% and 0.1% respectively).

3.2. Stem diameter

There was a significant result of seed rate on stem diameter. At 60 DAS, S1 showed the highest stem diameter (1.51 cm), which was statistically superior over S2 and S3. However, the stem diameter of S2 was statistically similar with S3. At 75 DAS, the stem diameter of S1 was statistically similar with a stem diameter of S2. The stem diameter on S3 (1.48 cm) was smaller than both S1 (2.26 cm) and S2 (2.00 cm). Also, at 90 DAS, the stem diameter of S3 (1.88 cm) was lesser compared to the stem diameter of S2 (2.3 cm) and S1 (2.4 cm). S2 and S3 were not statistically different from each other. Sowing methods did not show a significant difference in the stem diameter of sunflowers. Bindu et al. (2017) also resulted that there was no significant difference in stem diameter due to sowing methods. Furthermore, the interaction of seed rate and sowing methods failed to produce any significant effect on stem diameter.

3.3. Head diameter

Head diameter was significantly affected by seed rate and sowing methods. As per Table 2, the largest head diameter (17.84 cm) was attained with S1, which was followed by S2 (16.26 cm) and S3 (15.32 cm). Due to the decrease in the allocation of nutritional resources in higher densities compared to more lax population, head diameter in increased plant population density decreases (Esechie et al. 1996). Mousi et al. (1983), El-Tabbakh (1994), Basha (2000), Allam et al. (2003), Mojiri and Arzani (2003), Beg et al. (2007), Ibrahim and El-Genbehy (2009), Ibrahim M (2012) supported that head diameter decreases with an increase in plant population density. Also, the maximum head diameter was observed on the ridge sowing method (18.14 cm). The minimum head diameter was found on the broadcasting method (15.41 cm) which was statistically at par with line sowing method (15.87 cm). The main reason behind this result could be that plants met its requirements from loosened surface fertile soil and ridge planting created favorable soil environments for plant growth, which augments head diameter (Ahmad et al., 2000). Saleem et al. (2008) showed the maximum head diameter in the plots sown on ridges while the minimum was observed in-furrow planted plots. There was no significant difference in head diameter due to the interaction effect of seed rate and sowing method.

3.4. Seeds per head

It was observed that seeds per head were significantly affected due to seed rate. The number of seeds per head was found higher in S1 (925.3). An increase in the head diameter associated is with an increase in seeds per head. The minimum number of seeds per head was found on S3 (587.3). This result is in line with the finding of Esechie et al. (1996), who reported that the number of seeds per head decreases with an increase in plant population density. Similar results were reported by Jose et al. (7 Oct 2003). A maximum number of seeds per head was observed in M3 (862.2). This result was followed by M2 (716) and M1 (672.4), respectively.

This result is supported by Saleem et al. (2008), who reported that among different sowing methods, the ridge-planted crop produces the highest number of achene/head followed by flat sown crop; bed sowing resulted in the lowest number of achene/head. This is because, at ridge sowing, there is loosen the soil as compared to other methods. The plants can meet their requirements easily from loosening surface soil, which augments higher head diameter, head weight and seeds per head. The interaction effect of seed rate and sowing methods showed a significant difference in seeds per head. As shown in Table 3, seeds per head were significantly maximum in the interaction of 8 Kg/ha and ridge sowing method (1044.1). This result was followed by interaction between 8 Kg/ha and line sowing (904.5), which was at par with a result of interaction between 10 Kg/ha and ridge sowing (894.7) and the effect of interaction between 8 Kg/ha and broadcasting (827.4). The minimum number of seeds per head was found on the interaction of 12 Kg/ha and broadcasting (548.5). A lower number of seeds per head at this interaction might have resulted from high competition between plants.

3.5. Thousand-grain weight

The mean thousand-grain weight varied from 41.03 g (S3) to 41.77 g (S1). S1 appeared significantly superior to S2, which was further superior to S3 in terms of thousand-grain weight. A higher density of plant population leads to lower thousand-grain weight due to the decrease in the allocation of nutritional resources in higher densities compared to more lax populations. This result is in line with the finding of Esechie et al. (1996), who reported that thousand-seed weight decreases with an increase in plant population density. Similar results were reported by Mousi et al. (1983), El-Tabbakh (1994), Basha (2000), Allam et al. (2003), Ibrahim and El-Genbehy (2009) and Ibrahim M. (2012). Thousand-grain weight was significantly affected by the sowing method. A maximum thousand-grain weight was observed in M3 (45.24 g). This result was followed by M2 (41.11 g) and M1 (37.92 g), respectively. A similar result is reported by Ahmad et al. (2000) and Saleem et al. (2008), who found that among different sowing methods, the ridge-planted crop produces the highest thousand-grain weight followed by flat sown crop; bed sowing resulted in the lowest thousand-grain weight. There was no significant difference in the result of the thousand-grain weight due to the interaction effect of seed rate and sowing method.

3.6. Grain yield

Based on the seed rate, the result was significantly different on grain yield. The maximum grain yield 2.13 t/ha was found on treatment S2 (10 Kg/ha) while maximum seed rate 12 Kg/ha gave minimum grain yield i.e., 1.76t/ha. The grain yield of seed rate 10 Kg/ha was statistically at par with a result of S1. Similarly, Narwal and Malik (1985) reported that grain yield is low in high density and high in the low density of the plant. However, El-Tabbakh (1994), Basha (2000), Allam et al. (2003), Jose et al. (2003), Ibrahim and El-Genbehy

(2009) and Ibrahim M. (2012) reported that the lowest density gives the significantly lowest value for seed yield per hectare. Sowing methods significantly affected grain yield. The maximum grain yield was found on M3 (2.68 t/ha) as compared to M2 (1.87 t/ha) and M1 (1.39 t/ha). The increased yield was generally associated with increased head diameter, the number of seeds/head and thousand-grain weight. This result is supported by Esechie et al. (1996), Ahmed et al. (2000) and Saleem et al. (2008). No significant effect on grain yield due to interaction between seed rate and sowing method was observed.

Table: 2 Effect of different seed rates and sowing methods on Head diameter, Seeds per head, Thousand-grain weight and Grain yield.

Treatments	Head diameter (cm)	Seeds per head	Thousand-grain weight (g)	Grain yield (t/ha)
Seed Rates				
S3	15.32 ^c	587.3 ^c	41.03 ^c	1.76 ^b
S2	16.26 ^b	738 ^b	41.48 ^b	2.13 ^a
S1	17.84 ^a	925.3 ^a	41.77 ^a	2.04 ^{ab}
LSD _{0.05}	0.892 ^{***}	30.4 ^{***}	0.1844 ^{***}	0.26 [*]
Sowing Methods				
M3	18.14 ^a	862.2 ^a	45.24 ^a	2.68 ^a
M2	15.87 ^b	716 ^b	41.11 ^b	1.87 ^b
M1	15.41 ^b	672.4 ^c	37.92 ^c	1.39 ^c
LSD _{0.05}	0.892 ^{***}	30.4 ^{***}	0.1844 ^{***}	0.26 ^{***}

(Means followed by different letters within column are significantly different based on DMRT at P = 0.05; LSD = Least significant difference; NS = Non-significant; * and *** indicate level of significance at 5% and 0.1% respectively).

Table: 3 Interaction effect of seed rate and sowing method on seeds per head.

Seed rates	Seeds per head		
	Sowing Methods		
	M3	M2	M1
S1	1044.1 ^a	904.5 ^b	827.4 ^b
S2	894.7 ^b	677.9 ^c	641.4 ^{cde}
S3	647.8 ^{cd}	565.6 ^{de}	548.5 ^e
LSD _{0.05}	52.66 ^{**}		

(Means followed by different letters within column are significantly different based on DMRT at P = 0.05; LSD = Least significant difference; ** indicates level of significance at 1%).

4. Conclusion

From the present experiment, it can be concluded that the yield of sunflower was affected by seed rates and sowing methods. Though a higher plant population was observed with increased seed rate, stem diameter decreased with an increase in seed rate. Different sowing methods did not produce a remarkable effect on plant population and stem diameter. Head diameter, seeds per head and thousand-grain weight were observed better with a decrease in seed rate. All those characteristics, as well as grain yield, were superior in the ridge sowing followed by line sowing and broadcasting. The highest grain yield (2.13 t/ha) was found in 10 Kg/ha seed rate, which was statistically similar with grain yield found in 8 Kg/ha (2.04 t/ha). A seed rate of 8 Kg/ha and ridge sowing method had the best performance in terms of these traits and could be recommended to farmers for sunflower cultivation.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authorship contribution statement

The aforementioned authors have participated substantially in design of the study, data acquisition, analysis, interpretation and writing of this manuscript. We further confirm that the order of authors listed in the manuscript has been approved by us.

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