Seed priming and nitrogen management on growth and yield of zero till sunflower (*Helianthus annuus* L.) succeeding rice.

ABSTRACT

Aim: To determine the effect of seed priming and nitrogen management on growth, yield and economics of sunflower.

Study design: Split plot

Place and Duration of Study: Krishi Vigyan Kendra, Palem, between December 2021 and March 2022.

Methodology: A field experiment was conducted at Krishi Vigyan Kendra, Palem, Nagarkurnool (District) during *rabi* 2021-22 to assess the effect of seed priming and nitrogen management on growth and yield of zero till sunflower (*Helianthus annuus* L.) succeeding rice. The experiment was assigned in twelve treatments, laid out in split plot design with three replications. Treatments included were 4 treatments of seed priming methods (i) M_1 = Control (no priming) (ii) M_2 = Hydropriming (iii) M_3 = Osmopriming with KNO_3 @ 0.1% (iv) M_4 = Osmopriming with NaCl @ 0.1% and 3 nitrogen levels (i) S_1 = 100% RDN (ii) S_2 = 100% RDN (iii) S_3 = 150% RDN (RDN randomly placed in sub plots of the main plot.

Results: Significantly higher seed yield (1961 kg ha^{-1}), stalk yield (3562 kg ha^{-1}) was recorded under osmopriming with KNO_3 @ 0.1% (M_3). Similarly maximum seed yield (1944 kg ha^{-1}), stalk yield (3513 kg ha^{-1}) was observed in 150% RDN (S_3). The lower yield was recorded in M_1 in seed priming practices whereas it was S_1 (control) as in case of nitrogen levels. Exceptionally higher net returns was observed in M_3 i.e osmopriming with KNO_3 (Rs.86401 ha^{-1}) and S_3 i.e application of 150% RDN (Rs.84682 ha^{-1}).

Conclusion: Adoption of seed priming methods results in higher plant stand and nitrogen levels increases the crop yield.

Keywords: *seed priming, osmopriming, fertility levels, growth parameters and yield attributes*

1. INTRODUCTION

Oilseeds occupy an important position in Indian agriculture being next to food grains as a farm commodity. Sunflower (*Helianthus annuus* L.) is one of the major oilseed crops of India. It has been described as “drenched with sun-vitality” because the head follows the sun, ending up facing the west “to absorb the few last rays for the dying sun” (Nagaraj, 1995). Moreover, sunflower has the potential to produce the highest oil yield per hectare and is also a good source of honey. Globally, sunflower covers 27.4 M. ha with the productivity of 2049 kg ha^{-1} whereas, India cultivates sunflower in 0.226 M. ha with productivity of 1011 kg ha^{-1} and in Telangana, sunflower cultivated in an area of 0.007 M. ha with a productivity of 2342 kg ha^{-1} in 2020-21 (Indiastat 2021). India during 2019 imported around 15 Mt of edible oils (of which sunflower has 16% share next to palm oil and soya oil) worth approximately Rs. 7,300 crore, which accounted for 40 per cent of the agricultural imports bill and three per cent of the overall import bill of the country. Therefore, it is highly desirable to supplement our oilseeds production through the cultivation of sunflower. Increase in sunflower area during rabi season is possible as irrigation potential was increased in Telangana enables the farmer’s to go for second crop during rabi season after kharif rice and to zero tillage is one of the option for timely sowing of rabi crop.

Sunflower can play a key role in meeting the shortage of edible oils in the country. Among oilseed crops, sunflower has gained much popularity and the area under its cultivation is gradually increasing because of its short duration, photo-insensitivity, wider adaptability to different agro-climatic regions and soil types. In addition to higher seed multiplication ratio, its good oil quality, tolerance to drought and production of more oil per unit area and time than any other oilseed crop makes it a potential oilseed crop especially under rainfed and irrigated conditions. However, sunflower in India is grown on marginal lands with low organic matter and poor fertility status with inadequate application of major nutrients like nitrogen. As soils under rainfed condition are low in organic carbon status (Srinivasarao et al., 2003) there is a need to enhance application of nutrients either in organic or inorganic form for improving productivity.

In recent years, there has been renewed focus on resource conservation technologies, viz. reduced tillage, maintenance of vegetative cover and crop rotation, which in totality are called conservation agricultural practices (Venkateswarlu et al., 2010). Conservation agricultural practices reduce the cost of cultivation, control erosion and compaction (Meena, 2010). Conservation tillage systems improve land productivity by way of improved soil physical properties, reduced soil loss and enhanced soil organic carbon and greater retention of moisture (Nyakatawa et al., 2001). Stand establishment is of primary importance for optimizing field production of any crop plant especially under conservation tillage. At suboptimal environment conditions, poor seed germination and subsequently poor plant establishment is a common phenomenon. It has been reported that one of the major obstacles to high yield and production of crop plants is the lack of synchronized crop establishment due to poor weather and soil conditions (Mwale *et. al*., 2003). Strategies for improving the growth and development of crop species have been investigated for many years. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role. Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. Seed priming is employed for better crop stand and higher yields in a range of crops.

Seed priming is the control hydration of seeds in water or a solution of low osmotic potential to initiate the germination metabolism without radical protrusion. Many studies have reported that seed priming improves the stand establishment and productivity of field crops (Farooq et al. 2005.) Improved seed invigoration techniques are known to reduce emergence time, accomplish uniform emergence, and give better crop stand in many horticultural and field crops (Ashraf and Foolad 2005). Seed priming technology has twofold benefits: enhanced, rapid and uniform emergence, with high vigor and better yields in vegetables and floriculture (Bruggink et al. 1999) and some field crops (Basra et al. 2005; Kaur et al. 2005). According to McDonald (2000), primed seeds acquire the potential to rapidly imbibe and revive the seed metabolism thus enhancing the germination rate. Sedghi et al. (2010) found that seed priming with sodium chloride or potassium nitrate improved the stand establishment and seedling growth of sunflower.

Osmopriming is methodologically, technically and financially more exacting than hydropriming (Moradi and Younesi 2009) because the osmotic seed priming produces quicker and easier results and is far less expensive than most water conservation techniques, and offers farmers a highly attractive alternative for improving crop establishment and yields (Foti et al. 2008).

Nitrogen is the most important nutrient, which determines the growth of the sunflower crop and increases the amount of protein and the yield. Furthermore, nitrogen fertilizer application affects dry matter production as well as nitrogen accumulation and partitioning into various parts of crop plants for the growth, development and other processes (Khaliq and Cheema, 2005). Fertilizer needs of common sunflower cultivars vary based on ecological conditions annul precipitations, irrigation regimes and plant species. Higher nitrogen doses improve photosynthesis process, increase leaf area and net digestion rates (Munir et al., 2007). However, excessive nitrogen application may result in environmental pollution, imbalanced plant nutrition, decreased quality and increased production cost (Gokul et al., 2006). Therefore, proper nitrogen doses should be so selected as to improve yield and quality but to prevent negative impacts on human and soil health.

Information on response of sunflower to seed priming techniques and nitrogen management under conservation tillage were meagre and needs to be generated for increasing the sunflower area and production during *Rabi* season for increased edible oil production.

2. MATERIAL AND METHODS

Experimental site: The study was conducted at Krishi vigyan kendra, Palem, Nagarkurnool(District), Telangana during rabi season of 2021-22. The experiment was laid out in the split plot design with twelve treatments and replicated thrice. Treatments included were 4 treatments of seed priming methods (i) M_1 = Control (no priming) (ii) M_2 = Hydropriming (iii) M_3 = Osmopriming with KNO_3 @0.1% (iv) M_4 = Osmopriming with NaCl @0.1% and 3 nitrogen management practices (i) S_1 = 100% RDN (ii) S_2 = 125% RDN (iii) S_3 = 150% RDN

Seed Priming

Hydropriming: Sunflower seeds were soaked in aerated distilled water for 12 hours and shade dried

Osmopriming: Sunflower seeds were soaked in aerated solutions of 0.1% KNO_3 and 0.1% NaCl.

Crop husbandry: The seeds were sown on 16th of December by dibbling method in the pattern of row to row distance of 45 cm and plant to plant distance of 20 cm. A uniform dose of 90 kg P_2O_5 and 30 Kg K_2O kg ha^{-1} were applied through single super phosphate and Muriate of Potash, respectively as basal and Nitrogen (Recommended Dose of Nitrogen – 75 kg ha^{-1}) was applied through Urea as per the treatments in split doses as half of the nitrogen as basal and remaining half in two equal splits at 30 and 50 DAS as top dressing. The fertilizers were band placed from the crop row. Borax spray was done uniformly @ 2g/l of water to capitulum at ray floret opening stage to improve seed set and seed filling.

Observations:

Germination percentage

Germination percentage was calculated using formula:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings germinated}}{\text{Total number of seeds placed for germination}} \times 100$$

Vigour index

The seedling vigour index was calculated according to the following formula of Abdul-Baki and Anderson (1973).

Seedling vigour index = (seedling length (cm) x Germination percentage

Germination Index

Germination index was calculated using formula described by AOSA (1983).

$$\text{Germination index} = \frac{\text{No. of germinated seeds}}{\text{Days of first count}} + \cdots + \frac{\text{No. of germinated seeds}}{\text{Days of final count}}$$

Time to 50% seedling emergence

The time to get 50% emergence was calculated according to the following formulae of Coolbear et al. (1984) modified by Farooq et al. (2005).

$$E50 = ti + \frac{\left(\frac{N}{2} - ni\right)(tj - ti)}{nj - ni}$$

Where N is the final number of emergence and ni, nj cumulative number of seeds germinated by adjacent counts at times ti and tj when ni < N/ 2 < nj.

Data on agronomic and yield related traits were recorded at harvest maturity following the standard procedures. For plant height, five plants were selected at randomly in each plot and measurement was taken from base to the tip. Head diameter of five plants were taken from each plot and averaged, Data regarding 1000-grain weight from each replication was recorded in grams. For seed yield, five representative plants was harvested and threshed manually, and then clean seeds were air dried, bulked and weighed while stalk weight from each plot was determined from sundried samples and expressed in t ha^{-1}. Harvest index (%) was expressed as the ratio of seed yield to total above ground biomass and multiplied with 100**.**

3. RESULTS AND DISCUSSIONS

3.1 Growth parameters

The data presented in (Table 1 & Table 2) shows the seed priming methods had shown significant difference among crop establishment parameters of sunflower and growth parameters were shown in Table 3. The M_3 treatment recorded higher germination percentage (91.3), leaf area (2582 cm^2), initial population and final plant population (101407, 100518 plants ha^{-1}) (The nitrogen management practices recorded significantly higher plant height and other crop growth parameters. The 150% RDN (S_3) had recorded significantly higher plant height at 30, 60 and 90 DAS. The maximum plant height at harvest was recorded in S_3 (99.77 cm). Significantly higher germination percentage (91.2), leaf area (2575 cm^2 $plant^{-1}$) and dry matter production (5448 kg ha^{-1}) were observed in treatment S_3 which differed significantly with S_2 and followed by 100% RDN. The control treatment recorded lowest growth attributes due to less availability of nutrients. Interaction effect of growth parameters of sunflower as influenced by main and sub treatments was found to be nonsignificant at all crop growth stages. The higher nitrogen levels increases the higher photosynthetic area and growth attributes like plant height, leaf area and dry matter. Seed priming induced the higher germination percentage, seedling vigour index and germination index along with higher plant stand. Similar findings were observed by Hussain *et al*. (2006) and Anwar *et al*. (2012).

3.2 Yield attributes and yield

The seed priming methods recorded significantly higher seed yield and stalk yield (Table 4). The M_3 treatment showed significantly higher seed yield (1961 kg ha^{-1}) and stalk yield (3562 kg ha^{-1}). The maximum head diameter (16.4 cm), no. of seeds $head^{-1}$ (534) were observed in M_3 followed by M_4. Among nitrogen levels 150% RDN recorded significantly higher yield attributes and yield (seed and stalk). Significantly higher head diameter (16.1 cm), no. of seeds $head^{-1}$(551), seed yield (1944 kg ha^{-1}) and stalk yield (3513 kg ha^{-1}) were recorded in 150% RDN (S3).

Seed yield and stalk yield of 150% RDN (S_3) is significant with 125% RDN (S_2) and lowest was recorded with 100% RDN (S_1). The interaction effect due to seed priming methods and nitrogen management practices on yield attributes, seed yield and stalk yield of safflower was non significant. Increased seed yield of sunflower was due to increase in final plant stand and yield attributes like head diameter, number of seeds $head^{-1}$ and 1000 seed weight as observed in the present investigation. Increased Nitrogen availability increased the carbon assimilation, photosynthesis, canopy development (Massingam et al. 2003) and increased dry matter production and its better partitioning resulted in improvement of yield attributing characters, culminating in higher seed yield and stalk yield which was clearly observed in case of S_3. Similar findings were also reported by Khaliq *et al*. (2004).

3.3 Harvest index

The data presented in (Table 4) visualize that the seed priming methods and nitrogen management practices have conspicuous effect on harvest index. Significantly higher harvest index was noted with M_4 and lower harvest index with M_3. A higher harvest index was observed in case of 100% RDN (S_1) (32.75) followed by 125% RDN (S_2) whereas the lowest with 150% RDN (S_3).

3.4 Economics

The data regarding gross returns, net returns and returns per rupee investment of zero tillage sunflower as influenced by seed priming and nitrogen management was represented in Table 5.

Maximum gross returns (119765 Rs. ha^{-1}) was realized for the treatment M_3 (osmopriming with KNO_3 @0.1%) and S_3 (118285 Rs. ha^{-1}) (application of 150% RDN) and lowest gross returns was recorded under M_1 (control) (98070 Rs. ha^{-1}) and S_1 (100% RDN) (100774 Rs.ha^{-1}). The same trend was reflected in net returns and returns per rupee investment. Osmopriming with KNO_3 and application of 150% RDN contributed to higher seed yield and as it is practiced under zero tillage conditions which lead to low cost of cultivation inturn resulted in higher gross returns, net returns and returns per rupee investment as compared to other treatments. Similar reports were recorded by Narayana and Patel (2002) and Singh *et al*. (2007)

Table 1. crop establishment parameters of sunflower as influenced by seed priming methods and nitrogen levels.

Treatment	Germination percentage	Time to 50% seedling emergence	Initial plant population	Final plant population
Seed priming				
M_1-Control	88.2	4.67	98,024	96,914
M_2 - Hydropriming	89.2	4.11	99,086	98,531
M_3-Osmopriming (0.1% KNO_3	91.3	3.00	101,407	100,518
M_4-Osmopriming (0.1% NaCl	89.5	3.33	99,395	98951
SE(m)	0.23	0.10	356.087	237.8
CD(P=0.05)	0.83	0.33	914.253	838.7
Nitrogen levels (kg ha^{-1})				
S_1-100% RDN	88.0	3.92	97,778	97,028
S_2-125% RDN	89.4	3.83	99,315	98,648
S_3-150% RDN	91.208 (a)	3.58	101,343	100,509
SE(m)	0.28	0.15	312.8	245.8
CD(P=0.05)	0.85	NS	945.7	743.1
Interaction				
SE(m)	0.41	0.30	572.7	411.8
CD(P=0.05)	NS	NS	NS	NS

Table 2. Germination index and seedling vigour index of sunflower as influenced by seed priming techniques

Treatment	Germination index	Seedling vigour index
M_1-Control	20.5	1282
M_2-Hydropriming	24.0	1433
M_3-Osmopriming (0.1% KNO_3)	28.7	1954
M_4-Osmopriming (0.1% NaCl)	26.0	1625
SEm±	0.6	42
CD (P=0.05)	2.1	144

Table 3. Growth parameters of sunflower as influenced by seed priming methods and nitrogen levels.

Treatment	Plant height (cm)			Leaf area (cm^2)			Dry matter accumulation		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Seed priming methods									
M_1	34.2	102.5	147.0	1334	2344	1682	628	3288	4674
M_2	36.6	106.6	156.1	1387	2472	1760	768	3497	5167
M_3	37.6	113.1	163.6	1470	2582	1872	942	3763	5448
M_4	36.7	110.9	157.6	1417	2503	1812	802	3527	5159
SEm±	0.3	0.7	3.2	15	17	17	27	57	82
CD (P=0.05)	0.9	2.0	NS	52	61	59	96	201	284
Nitrogen levels									
S_1	34.1	101.4	141.1	1341	2398	1716	658	3067	4726
S_2	36.4	109.6	157.4	1389	2452	1762	804	3594	5156
S_3	38.3	113.8	169.8	1475	2575	1857	894	3896	5454
SEm±	0.7	1.2	2.6	10	18	10	19	100	73
CD (P=0.05)	2.1	3.6	7.7	29	53	29	59	300	217
Interaction									
SEm±	0.2	2.4	5.1	22	32	23	42	173	148
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: cm- centimeter, DAS-Days after sowing, NS- Non significant

Table 4. Effect of seed priming methods and nitrogen levels on yield attributes and yield of sunflower.

Treatments	Head diameter (cm)	No. of filled seeds head^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)	Threshing percentage	Oil content
Seed priming methods								
M_1	13.3	506	39.27	1654	3101	34.7	75.0	42.08
M_2	14.6	522	39.54	1857	3364	35.6	76.9	42.44
M_3	16.4	534	41.20	1961	3562	35.5	79.0	43.09
M_4	15.2	523	40.78	1867	3373	35.7	77.1	42.88
SEm±	0.3	3	0.50	25	69.1	0.3	0.5	0.41
CD (P=0.05)	1.1	9	NS	87	239	0.8	1.8	NS
Nitrogen levels								
S_1	13.7	492	39.88	1724	3204	35.0	74.6	42.32
S_2	14.7	521	40.29	1837	3333	35.5	76.8	42.47
S_3	16.1	551	40.42	1944	3513	35.6	79.7	43.09
SEm±	0.2	4	0.40	31	51	0.2	0.3	0.27
CD (P=0.05)	0.7	12	NS	93	152	0.5	0.8	NS
Interaction								
SEm±	0.5	8	0.76	56	108	0.8	0.7	0.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Effect of seed priming methods and nitrogen levels on economics of sunflower.

Treatments	Gross returns	Net returns	Returns per rupee investment
Seed priming methods			
M_1	98070	64716	1.94
M_2	108239	74885	2.24
M_3	119765	86401	2.59
M_4	108972	75610	2.27
Nitrogen levels			
S_1	100774	67660	2.04
S_2	107225	73867	2.21
S_3	118285	84682	2.52

4. CONCLUSION

Comparing osmopriming with KNO_3 to other seed priming techniques, it can be said that osmopriming with KNO_3 and application of 150% RDN was more cost-effective in obtaining better seed yields and high net returns. Osmopriming with 0.1% KNO_3 ensures sunflower production in areas where zero tillage is practiced and frequent crop failure are normal occurrences.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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