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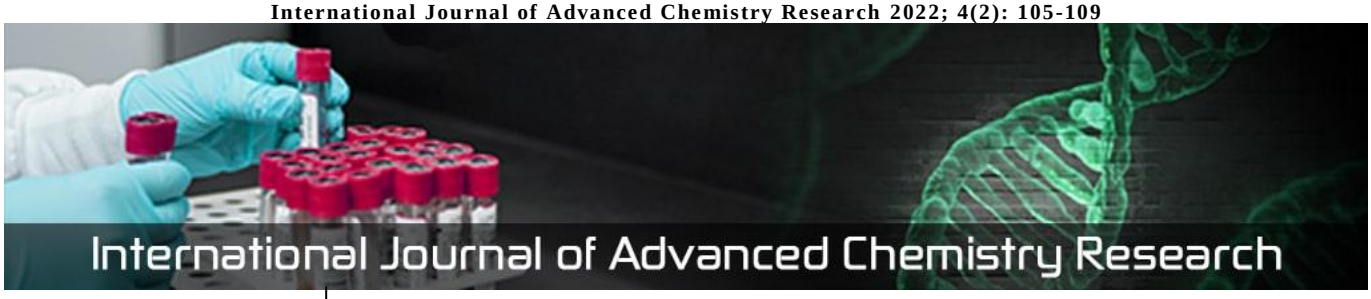

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Effect of different crop establishment methods and weed management on chickpea under direct seeded rice-based cropping system in conservation agriculture

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Abstract
The field experiment was carried out at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) to evaluate the effect of different crop establishment methods and weed management practices on chickpea in rice based cropping system during 2019-20 and 2020-21. The soil of the experiment field was clay in texture, neutral in reaction, low in organic carbon, low in nitrogen and low in phosphorus and high in potassium contents. The experiment was planned in split plot design with three replications, having three different crop establishment methods *viz*,. Zero seed drill (T_1), Happy seed drill (T_2) and Normal seed drill (soil preparation only by rotavator) (T_3) in main plot, three weed management practices *viz*., W_1: Chemical weed control, W_2: Hand weeding twice and W_3: Unweeded check control in sub plot respectively. Recommended dose of fertilizer used were 20:50:20:20 kg N:P_2O_5:K_2O:S ha^{-1}, respectively. The result of the experiment revealed that highest growth parameters, yield attributes, seed yield (Mean *viz.* 1654 kg ha^{-1}) and stover yield (Mean *viz.* 2019 kg ha^{-1}) of chickpea were obtained under the adoption of happy seed drill (T_2) followed by normal seed drill (soil preparation only by rotavator) (T_3) during both years of result including mean value. However zero seed drill was least effective in increasing the yield of chickpea during both years of experiment. Among weed management, hand weeding twice recorded the maximum seed yield (Mean *viz.* 1740 kg ha^{-1}) and stover yield (Mean *viz.* 2223 kg ha^{-1}) of chickpea as compare to unweeded control.

Keywords: Crop establishment methods, weed management, chickpea yield attributes and yield

1. Introduction

Rice based cropping system can be described as mix of farming practices that comprises of rice as the major crop followed by subsequent cultivation of other crops. Rice-based cropping systems have been reported from different parts of India ranging from rice-rice-rice to rice followed by different cereals, pulses, oilseeds, vegetables and fiber crops. (Deep *et al.*, 2018) [7]. In Chhattisgarh, the existing practices of rice based rainfed double crops are rice-gram, rice-lathyrus, rice-linseed, rice-pea, rice-lentil *etc*. Their productivity depends upon the time and method of sowing, plant stand, winter rainfall pattern etc.

Pulses have very low productivity due to several reasons, however, the obvious reasons are cultivation under energy starved conditions on marginal and sub-marginal lands with no or low input management, late sowing, higher degree of susceptibility to both abiotic and biotic stresses, high yielding varieties, improper management practices, lack of winter precipitation and inadequacy of stored soil moisture, *etc* (Ali and Mishra, 2000) [1]. Pulses such as deep root system, ability to utilize the moisture from deeper soil layers, low water requirement and crop establishment by surface seeding are the desirable characters for a moisture-limited environment of the rice fallows (Hazra *et al*. 2014; Kumar *et al*. 2016) [8, 16]. Studies on relative productivity of various pulse crops in rice fallows indicated that cowpea recorded highest productivity, followed by urdbean at Berhampur, but at Raipur, lathyrus, lentil and mungbean were more productive (Ali, 2004) [2]. At Kanpur, Kumar and Ali (1998) [14] evaluated various pulses and oilseed crops after rice and found that lentil, lathyrus and linseed were more productive and remunerative than chickpea, fieldpea, and rajmash. Chickpea (*Cicer arietinum* L.) is the most important pulse crop of India, sharing 29.7 and 38

% of the total area and production of total pulses, respectively (Chand *et al*., 2010) [5]. Chickpea is valued for its nutritive seeds with high protein content (18-22 %), carbohydrate (52-70 %), fat (4 - 10 %), minerals and vitamins after dehulling. In India chickpea is grown over an area of 9547.03 thousand ha, yielding out 9937.99 thousand tonnes and productivity of 1041 kg ha^{-1} (Anonymous, 2018) [3]. In Chhattisgarh, chickpea is grown over an area of 321.50 thousand ha with a production of 329.86 thousand tonnes and productivity of 1026 kg ha^{-1} (Anonymous, 2018) [3].

Weeds can be controlled by different methods such as manual, mechanical, and chemical methods. Generally, for the weed management, farmers do manual weeding, but manual weed management is always laborious, expensive, time consuming, uneconomical and needs to be often repeated at different intervals, as compared to chemical weed management. Chickpea is poor competitor to weeds because of slow growth rate and limited leaf development at early stage of crop growth and establishment, if weed management is neglected under these conditions, resulting in yield loss of 40 to 87% (Solh and Pala, 1990; Chaudhary *et al*., 2005) [21, 6]. The critical period for crop-weed competition in chickpea is 30 to 60 days (Kumar and Singh, 2010) [13].

Conservation agricultural practices have increasingly relied on herbicide use. Increased use of herbicides revolutionized agriculture and increased yields by 25% (Singh, 2014) [20]. Herbicides play an important role in controlling weeds during the first years after the adoption of conservation agriculture, at least, in large cropping areas where hand weeding would be inefficient. Three to four years after starting conservation agriculture, herbicide may still need to be applied in some environments, based on a location-specific knowledge of weeds. Continuous cropping under conservation agriculture will tend to reduce such population as soil is not left bare. In practice, conservation agriculture ultimately offers weed control advantages as weed seeds are no longer spread and incorporated in the soil, or dug up to the soil surface or redistributed through roots parts and it allows the integration of different practices, which makes the system more sustainable.

2. Materials and methods

2.1 Experimental Site Description and climatic condition

The field experiment was conducted at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). Geographically, Raipur is situated in central parts of Chhattisgarh and lies at latitude, longitude and altitude of 21°4'N, 81°35' E and 290.20 meters above mean sea level, respectively. The soil of the experiment field was clay in texture, neutral in reaction, low in organic carbon, low in nitrogen and low in phosphorus and high in potassium contents. The experimental area, (Raipur) comes under the 7th Agro-climatic region of India *i.e.* "Eastern Plateau and Hills" which is classified as sub-humid with hot summer and cold winter. The average rainfall is 1325 mm (based on 80 years mean), out of which about 87 percent received during the rainy season (June to September) and the rest 13 percent during the winter season (October to February). The maximum and minimum temperature goes to 46^0C and 6^0C in the months of May and December or January, respectively.

2.2 Experimental Design and Treatment details

In the field experiment, the effect of continuous methods of sowing practices and weed management in *rabi* season investigated. The experiment was laid out in split plot design with three replications. Treatments comprised of three methods of sowing *viz*., T_1: zero seed drill, T_2: happy seed drill and T_3: normal seed drill (soil preparation only by rotavator) in main plot, three weed management practices *viz*., W_1: chemical weed control, W_2: hand weeding twice and W_3: unweeded check control in sub plot respectively.

2.3 Agronomic Management

The field preparation of experimental field during *rabi* was done as per the treatment. Under normal seed drill treatment, the field was ploughed only by rotavator. No additional tillage practice was implemented in the zero tillage. Rice crops (Rajeshwari) were harvested by manually, leaving all residues in the field and the loose residues were manually spread uniformly over the plots before sowing by happy seeder of chickpea crop. Chickpea crop (Indira chana-1) was sown with seed drill cum fertilizer drill, zero till seed drill and happy seed drill. Spacing for chickpea was 20 cm row to row. Crop was sown on 15, November 2019 and 12, November 2020, during both the *rabi* seasons, respectively. Recommended dose of fertilizer used were 20:50:20:20 kg $N:P_2O_5.K_2O:S$ ha^{-1} as basal dose at the time of sowing, respectively. Hand weeding was done as per treatment with the help of khurpi at 20 and 40 days after sowing so as to keep the crop free from weeds during critical period of crop-weed competition. Chemical weed management was done by using pendimethalin @ 1 kg ha^{-1} as pre emergence herbicide. Irrigation was given immediately after sowing for ensure proper germination and plant stand, chickpea crop was provided with three irrigations, coincided with its critical stages of crop growth during both the year of experimentation. In plant protection prior to sowing the seed was treated with bavistin @ 2.5 g kg^{-1}.To protect from seed and soil borne diseases for chickpea protection from pod borer insect spray quinalphos @ 1.0 liters ha^{-1} at the time of pod formation stage. The harvesting was done manually with the help of sickle on 25 march, 2020 and 28 march, 2021. Crop was harvested at maturity when most of the plants turned into reddish brown color.

2.4 Data collection

Mature five plants of chickpea crop were randomly selected and uprooted from each treatment plot. Plot wise from these five plants, the data of plant height, number of branches per $plant^{-1}$, number of root nodules $plant^{-1}$, plant dry matter, pods $plant^{-1}$, number of seeds $plant^{-1}$, number of seeds $pods^{-1}$, respectively were recorded. Plant height was recorded from above ground part and averaged. Number of branches per plant was counted and averaged. Roots of three randomly selected chickpea and plants were uprooted carefully along with the nodules without any damage. The roots of the plant were washed in sieve with water and effective root nodules were separated and counted. Five randomly selected plants were uprooted carefully along with root from the border portion and detached shoot portion of the plant was sun dried followed by drying in hot air oven at 60 °C for 48 hours to record constant dry weight. The samples were weighed on an electronic balance and then average was worked. Pods were detached from every plant

and the number of pods per plant was counted and averaged. Five pods were separated randomly from composite pods of five plants from each plot. The number of seeds per pod was counted from five pods and averaged. For test weight hundred healthy seeds from the produce of each plot were counted and same were oven dried at 60°C till constant weight and weight was recorded accurately by using an electronic balance. For stover yield (kg ha^{-1}), mature plants were collected instead of border row in each plot at harvest time. The harvested plants were sun dried and seeds were separated. The dry straws were weighed and the weight was converted to kg ha^{-1}. For seed yield, total dried of each treatment plot was weighed and converted it to kg ha^{-1}.

3. Results and discussion

3.1 Growth and yield attributes of chickpea

The data on growth and yield attributes of chickpea as influenced different methods of sowing and weed management practices on the basis of two years mean are presented in Table 1 and Table 2.

Data concluded that different crop establishment methods and weed management significantly affect the plant height, number of branches $plant^{-1}$, number of root nodules $plant^{-1}$, plant dry matter number of pods $plant^{-1}$and number of seeds $plant^{-1}$.However data regarding number of seeds pod^{-1} and 100 seed weight did not differ significantly during both years of observations.

Among different methods of sowing, T_2: happy seed drill produced, significantly maximum plant height (Mean *viz*. 51.50 cm), number of branches $plant^{-1}$ (Mean *viz*.8.18), and plant dry matter (Mean *viz*.27.22 g $plant^{-1}$) at harvest and number of root nodules $plant^{-1}$ (Mean *viz*.13.06) at 60 DAS of chickpea, which was followed by T_3: normal seed drill (soil preparation only by rotavator) and the lowest values was observed under T_1: zero seed drill during both years and on mean data value. It was also found that maximum yield attributes *viz*., number of pods $plant^{-1}$, number of seeds $plant^{-1}$, number of seeds pods $^{-1}$ and 100 seed weight recorded under sowing method of happy seed drill, it is might be due to happy seed drill with rice residues of harvested rice crop increased the microbial activity, organic carbon, good soil tilth, buffering soil temperature, better moisture uptake and better resource utilization (Yogesh Kosariya and R.K. Naik 2019) [10, 11]. Special advantages with pulses crop that being short-duration, resilient and low-input requiring in natures, suggest an incredible prospect to use of residual soil moistures (Kar *et al.* 2004, Kar and Kumar 2009). H. S. Sidhu *et al*. (2014) reported that happy seeder significantly increase the growth parameters as compared to farmer's practice and rotavator in wheat crop.

In case of weed management practices, significantly maximum growth parameters *viz*., plant height (Mean *viz*. 49.66 cm), number of branches $plant^{-1}$ (Mean *viz*. 7.07), plant dry matter (Mean *viz*. 25.84 g $plant^{-1}$) at harvest and number of root nodules $plant^{-1}$ (Mean *viz*.11.47) at 60 DAS and yield attributes *viz*., number of pods $plant^{-}$, number of seeds $plant^{-1}$,number of seeds pods $^{-1}$ and 100 seed weight at harvest was observed with W_2: hand weeding twice due to the beneficial effect of reduced crop weed competition is apparent from the dry matter accumulation of chickpea under weed-free and weed-infested environments, which are ultimately reflected on growth and seed yield (Bhan and Kukula, 1986) [4]. Rathod *et al*. (2016) [17] also reported that the, significantly highest growth parameters of chickpea were recorded in two hand weedings at 20 and 40 days after sowing. However, the minimum values of these characters were observed under W_3: unweeded check control, during both the years and on mean basis.

3.2 Seed yield, stover yield and harvest index of chickpea

Data related to seed and stover yield of chickpea as influenced by different methods of sowing and weed management practices under direct seed rice based cropping system was counted at harvest. The data of respective parameters are depicted in Table 3.

The yields were comparatively higher in 2020-21 than in 2019-20. Although same cultivar ('Indira chana-1') was sown the almost at the same time and similar management practices were followed in the both years, the crop performance varied due to improved soil health and microclimatic conditions in subsequent year. Yields showed significant variation due to methods of sowing and weed management practices during both year and on mean value.

Among different methods of sowing the maximum seed and stover yield of chickpea (Mean *viz.*, 1654 kg $ha^{-1}$and 2019 kg ha^{-1}) was recorded under T_2: happy seed drill, which was followed by T_3: normal seed drill (soil preparation only by rotavator) (Mean *viz.*, 1421 kg ha^{-1} and 1852 kg ha^{-1}) and T_1: zero seed drill (Mean *viz.*, 1188 kg ha^{-1} and 1778 kg ha^{-1}) during both the year and on mean value. However, in 2020-21 the highest seed yield of chickpea was recorded under T_2: happy seed drill (Mean *viz*.1704 kg ha^{-1}). This effect was obviously due to high water and nutrient use efficiency and easy availability of plant moisture, better weed control, favorable soil environment, improved root-development. Similar results were reported by Zamir *et al.*, (2010) [22], Sharma *et al.*, (2008) [18], Izumi *et al.*, (2004) [9] and Merril *et al.*, (1996) [15], Naresh *et al.*, (2011) [16]. Kosariya *et al.* (2019) [10, 11] reported that, the significantly higher seed yield under happy seed drill might be attributed to the maximum dry weight $plant^{-1}$ and yield attributes character of chickpea.

Regarding weed management practices, W_2: hand weeding twice (Mean *viz.*, 1740 kg $ha^{-1}$and 2223 kg ha^{-1}) produced significantly higher chickpea seed and stover yield over remaining treatments. The W_3: unweeded control exhibited significantly lower seed and stover yield (Mean *viz.*, 956 kg ha^{-1} and 1304 kg ha^{-1}) of chickpea during both the years as well as in mean data of two years.

Among various combinations, significantly maximum seed and stover yield were produced under T_2: happy seed drill with W_2: hand weeding twice during both years of experiment and on mean value, which is might be due to the maintenance of weed free environment, especially during critical growth stages of crop growth as evident from increased in the values of growth attributes under these treatments Rathod *et al*. (2016) [17] also concluded that yield and yield parameters of chickpea differed significantly due to different weed control treatments. Higher yield and yield parameters was recorded in two hand weedings at 20 and 40 DAS, since no weeds were allowed to grow throughout the crop growth period which enabled zero crop-weed competition for resources throughout the crop growth period Whereas the combination T_1: zero seed drill and W_3: unweeded check produced the lowest seed and stover yield as compare to other combinations during both years and on mean data.

Table 1: Plant height (cm), number of branches plant-1, number of root nodules plant^{-1}, and plant dry matter (g plant^{-1}) of chickpea as influence by different method of sowing and weed management under direct seeded rice based cropping system

Treatment	At harvest											
	Plant height (cm)			Number of branches plant^{-1}			Number of root nodules plant^{-1} at 60 DAS			Plant dry matter (g plant^{-1})		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing												
T_1: Zero seed drill	43.12	43.57	43.34	5.48	5.54	5.51	9.40	9.98	9.69	20.21	20.91	20.56
T_2: Happy seed drill	51.14	51.87	51.50	8.17	8.20	8.18	12.82	13.29	13.06	26.60	27.84	27.22
T_3: Normal seed drill (soil preparation only by rotavator)	46.70	47.27	46.99	6.55	6.58	6.57	10.02	10.49	10.25	24.00	24.89	24.45
Sem±	0.49	0.26	0.22	0.08	0.16	0.05	0.23	0.18	0.06	0.78	0.81	0.79
CD (P=0.05)	1.91	1.01	0.87	0.33	0.62	0.20	0.91	0.71	0.24	2.34	2.43	2.38
Sub plot- Weed management												
W_1: Chemical weed control	47.03	47.81	47.42	6.92	6.95	6.94	10.88	11.35	11.12	23.21	24.78	24.00
W_2: Hand weeding twice	49.46	49.85	49.66	7.05	7.08	7.07	11.24	11.71	11.47	24.67	27.00	25.84
W_3: Unweeded check control	44.48	45.04	44.76	6.22	6.28	6.25	10.12	10.70	10.41	21.12	22.00	21.56
SEm±	0.50	0.48	0.28	0.23	0.19	0.13	0.22	0.22	0.07	0.44	0.51	0.47
CD (P=0.05)	1.53	1.49	0.87	0.70	0.58	0.42	0.68	0.68	0.22	1.32	1.53	1.42
Interaction (T X W)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: No. pods plant^{-1}, no. seeds pod^{-1}, no. of seeds plant^{-1} and 100 seed weight of chickpea as influence by different method of sowing and weed management under direct seeded rice based cropping system

Treatment	Number of pods plant^{-1}			Number of seeds pod^{-1}			Number of seeds plant^{-1}			100 seed weight (g)		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing												
T_1: Zero seed drill	30.86	31.37	31.12	1.33	1.41	1.37	43.44	44.15	43.80	19.13	19.59	19.36
T_2: Happy seed drill	43.10	45.64	44.37	1.36	1.43	1.40	61.78	65.48	63.63	22.88	23.32	23.10
T_3: Normal seed drill (soil preparation only by rotavator)	36.85	37.83	37.34	1.35	1.42	1.39	52.57	53.97	53.27	20.18	20.83	20.51
Sem±	0.28	0.47	0.26	0.01	0.02	0.01	0.53	1.21	0.85	0.84	0.81	0.76
CD (P=0.05)	1.08	1.84	1.02	NS	NS	NS	2.10	4.76	3.33	NS	NS	NS
Sub plot- Weed management												
W_1: Chemical weed control	38.07	39.09	38.58	1.34	1.43	1.38	54.30	55.74	55.02	21.06	21.49	21.27
W_2: Hand weeding twice	40.91	43.76	42.33	1.37	1.44	1.41	59.11	63.27	61.19	22.01	22.35	22.18
W_3: Unweeded check control	31.83	31.99	31.91	1.33	1.39	1.36	44.38	44.59	44.49	19.12	19.91	19.51
SEm±	0.34	0.43	0.19	0.03	0.02	0.02	0.52	1.01	0.64	0.79	0.63	0.56
CD (P=0.05)	1.05	1.32	0.59	NS	NS	NS	1.60	3.10	1.97	NS	NS	NS
Interaction (T X W)	S	S	S	NS	NS	NS	S	S	S	NS	NS	NS

Table 3: Seed yield, stover yield and harvest index of chickpea as influence by different method of sowing and weed management under direct seeded rice based cropping system

Treatment	Seed yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Harvest index (%)		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing									
T_1: Zero seed drill	1048	1129	1088	1738	1817	1778	36.86	37.75	37.30
T_2: Happy seed drill	1604	1704	1654	1979	2060	2019	44.73	45.72	45.22
T_3: Normal seed drill (soil preparation only by rotavator)	1380	1461	1421	1839	1864	1852	42.74	43.58	43.16
Sem±	9.90	7.46	4.33	11.19	12.70	5.91	0.27	0.28	0.12
CD (P=0.05)	38.86	29.31	17.00	43.93	49.88	23.21	1.05	1.10	0.47
Sub plot- Weed management									
W_1: Chemical weed control	1434	1501	1467	2094	2149	2121	40.26	40.92	40.59
W_2: Hand weeding twice	1688	1792	1740	2167	2278	2223	43.75	44.14	43.95
W_3: Unweeded check control	911	1001	956	1294	1315	1304	40.32	41.99	41.16
Sem±	9.45	11.20	9.28	16.26	23.83	16.36	0.26	0.40	0.28
CD (P=0.05)	29.13	34.50	28.60	50.10	73.41	50.41	0.79	1.22	0.86
Interaction (T X W)	S	S	S	S	S	S	S	S	S

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