EFFECT OF MOISTURE CONSERVATION PRACTICES WITH PROTECTIVE IRRIGATION AND NUTRIENT MANAGEMENT ON GROWTH, YIELD AND ECONOMICS OF RADISH AND TO AUGMENT THE WATER PRODUCTIVITY IN *ALFISOLS* IN THE SOUTHERN DRY REGION OF KARNATAKA

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ABSTRACT

A field experiment was conducted during Rabi, 2010 at All India Coordinated Research Project for Dry Land Agriculture, University of Agricultural Sciences, Bengaluru to evaluate moisture conservation practices with protective irrigation and integrated supply of nutrients on the growth and yield of radish crop. The eastern dry zone of Karnataka receives an annual rainfall of 927.9 mm in 62 rainy days and causes an average of 10-15% runoff over 20-25 runoff events. The excess rainfall collected as runoff in storage structures depends on rainfall intensity and duration, frequency of rainy days, soil texture and structure, soil slope, vegetation cover etc., The growth parameters viz., plant height, leaf area and dry matter accumulation and yield parameters viz., root length & root diameter and root yield differed significantly among moisture conservation practices with protective irrigation. Moisture conservation furrow + protective irrigation + mulching recorded significantly higher root yield (14287 kg ha^{-1}) as compared to moisture conservation furrow + protective irrigation and control (without protective irrigation) and mulching. Application of 100% of recommended dose of nitrogen through fertilizer recorded significant progressive growth parameters and yield parameters (root yield) as compared to integrated approach of nitrogen application viz., 50% RDN through farm yard manure + 50% through fertilizer and 50% through glyricidia + 50% RDN through fertilizers and both are on par with each other during 30 DAS and at harvest. Moisture conservation furrow + protective irrigation + mulching with application of 100% recommended dose of nitrogen through fertilizer recorded higher net returns and B: C ratio. It could be concluded that the higher root yield and net income in radish can be realized by adoption of soil moisture conservation practices and protective irrigation along with application of recommended dose of fertilizers. The runoff water collected in the farm pond and recycled for protective irrigation to radish certainly improved crop, water and soil productivity under scarce water resources enhancing the economic viability of the system and restoring the eco-system.

Key words: *moisture conservation practices, protective irrigation, Alfisols, nutrient management, radish, economics*

INTRODUCTION

Radish (*Raphanus sativus* Linn) is one of the most important vegetable crops grown in rainfed areas in India. It is very popular particularly for pickles, table use as salad and cooked vegetable. Besides its charterstic taste, leaves are also cooked with roots which are rich in protein, carbohydrates and iron. Thus, nutritionally radish is very important in human diet. It is a quick growing crop and in order to obtain good quality radish, its growth and development should be quick for which fertilizers and loose soil are needed. Mulching has been reported to conserve soil moisture and improve the yield of vegetable crops and hence can be useful in rainfed areas where moisture is limiting factor in the successful cultivation of vegetables [4]. Use of mulches in conservation of soil moisture and improving the crop yield has also been reported by several other workers. Therefore, the present study was undertaken to evaluate utilization efficiency of harvested water with moisture conservation practices and integrated nutrient management approach for radish production in *Alfisols*" in the Southern dry zone of Karnataka

In dry lands, a drastic change in soil water availability, severe erosion during peak runoff resulted in nutrient and runoff loss. In Karnataka State, a*lfisols* accounts for 27% of the total cultivated area possess poor water holding capacity and more prone to soil and water erosion due to surface crust formation; thus affect the potential crop production. The mean annual rainfall of Karnataka State is 1139mm distributed in 34 rainy days with a varience of 30-45%. The eastern dry zone of Karnataka receives an annual rainfall of 927.9mm in 62 rainy days and causes an average of 10-15% runoff over 20-25 events. The runoff water collected in the farm pond will be recycled as protective irrigation during dry spells to protect the crop.

MATERIAL AND METHODS

The experiment was conducted during *Rabi*, 2010 at AICRP for Dry Land Agriculture, University of Agricultural Sciences, Bengaluru in red sandy loam soils with pH 5.4, bulk density of 1.43 g/cc, 61.4% sand, 28.5% silt and 10.1% clay. The average organic carbon content was low (0.45%). The soil was low in available nitrogen (237.8 kg/ha), low in available phosphorus (18.3 kg/ha) and potassium (195.8 kg/ha). The electrical conductivity was 0.22 dS/m which indicated no salinity hazard. The experiment was laid out in split-plot design, replicated thrice. The size of each plot was 4.5 m x 3.0 m. Separate buffer furrow is maintained between each plot. The treatments consists of Moisture conservation practices with Protective Irrigation (M) *viz.*, M_1= Moisture Conservation furrow + Protective Irrigation + Mulching, M_2= Moisture Conservation furrow + Protective Irrigation, M_3= Control; and three different nutrient Sources (N), viz. N_1: Recommended dose of fertilizers, N_2: 50% recommended N through farm yard manure + 50% N through fertilizer and recommended P_2O_5 and K_2O, N_3: 50% recommended N through glyricidia manure + 50% N through fertilizer and recommended P_2O_5 and K_2O in sub plots. For sub-plot treatments, the nutrient composition of organic manures was analyzed and quantity of manures required to supply 50 per cent recommended N (37.5 kg N) was worked out and all the organic manures were applied 15 days before sowing as per treatments. Entire dose of recommended N, P_2O_5 and K_2O were applied at the time of sowing. Radish seeds (Cv. Pusa Chetki) were sown continuously in these furrows and later thinned out at 15DAS to maintain a plant spacing of 10cm. Hand weeding and intercultivation was carried out at 20 DAS. Two protective irrigations were provided during critical stages of the crop growth period except M_3. Approximately 5 cm depth of irrigation was provided during long dry spells of the crop growth. Observations on the growth components of radish were recorded at 30 DAS and at harvest. At harvest, root yield and yield attributes were recorded from sampling plants and mean values were worked out.

Large sized experimental plots with 2.5% slope with and with out conservation measures have been maintained since 20 years at the dry land research centre, Bangalore in order to quantify the soil and water loss through runoff. The harvested water stored in the farm pond was utilized for the production of radish crop.

RESULTS AND DISCUSSION

Effect of Moisture Conservation Practices With Protective Irrigation (M)

The data reveals that plant height (18 cm and 29.5cm) and no. of leaves (6.4 and 9.6) were significantly higher in moisture conservation furrow + protective irrigation + Mulching (M_1) at 30 DAS and at harvest respectively, as compared to moisture conservation furrow + protective irrigation (M_2) and control (without protective irrigation) (Table 1). The increased plant height was mainly due to production of relatively large amount of assimilates thereby favoring all the growth parameters. Significantly higher leaf area 142.4cm^2 and 338.9 cm^2 recorded in M_1 at 30DAS and at harvest respectively (Table 1). Highest leaf area might be due to the increased production of leaves in plants in mulched plots that leads to an increase leaf area [3]. Arandhi and Suryadi (1982) [2] reported marked increase in leaf area of potato under the influence of paddy straw.

The dry matter production and its distribution among different plant parts differed significantly due to moisture conservation furrow + protective irrigation and mulching. Total higher dry matter accumulation at 30DAS was noticed in M_1 (1.8 g plant $^{-1}$) and M_2 (1.5 g plant $^{-1}$) as compared to control (0.9 g plant $^{-1}$) respectively (Table 1). The trend was similar at harvest. This significant variation in dry matter distribution and accumulation in various plant parts lead to significant variation with respect to total dry matter production per plant at harvest. Higher total dry matter accumulation per plant at harvest was significant in M_1 (7.30 g plant $^{-1}$) as compared to M_2 and M_3.

Radish yield differed significantly among moisture conservation practices with protective irrigation (M), moisture conservation furrow + protective irrigation + mulching recorded significantly higher root yield (14287 kg ha^{-1}) as compared to M_2 and control (without protective irrigation). The higher yield level in M_1 could be attributed to alteration in land configuration by providing moisture conserving furrow, mulching and protective irrigation during long dry spell as compared to control. Higher root yield in mulching may be due to the combined effect of weed control, nutrient uptake and moisture conservation [5]. Apart from this, yield attributing parameters such as root length per plant (15.5cm), root diameter (3.43cm) were significantly higher in M_1, as compared to M_2 & M_3 (Table 2). Thus, owing to integrated effect of these yield parameters favorably influenced the root yield of radish. The yield and yield attributes depend upon production of photosynthates and their distribution among various structures. The synthesis, accumulation and translocation of assimilates depend upon efficient photosynthetic structure as well as the extent of translocation to sink. Differences observed in root yield of radish due to protective irrigation and mulching, production could be traced back to differences in dry matter production and its accumulation in different plant parts and relatively higher leaf area was observed in moisture conservation furrow + protective irrigation + mulching at all the growth stages of plant. N, P and K contents in root and shoot varied significantly by the soil moisture conservation practices + with and without protective irrigation (Table 3). N, P and K contents in root and shoot were maximum with moisture conservation furrow + protective irrigation + mulching among main plots. Soil moisture conservation practices coupled with the protective irrigation helped the plant to take up higher amounts of macro nutrients which in turn helped for production of higher photosythates and its translocation from source to sink effectively.

Effect of Different Sources of Nitrogen (N)

Application of nitrogen to radish by different sources (sub-plot treatments) had recorded differences in growth parameters of plant at various growth stages. Application of 100% of recommended dose of nitrogen through fertilizer recorded significant progressive plant height and no. of leaves (16.6cm & 5.8 and 26.6cm & 8.8 at 30DAS and at harvest respectively) at all the growth stages of crop growth as compared to integrated approach of nitrogen application *viz.*, 50% RDN through farm yard manure+50% recommended dose of nitrogen (RDN) through fertilizer and 50% through glyricidia+50% RDN through fertilizers both are on par with each other during 30 DAS and at harvest. Significantly higher leaf area was observed in treatment receiving 100% RDN through fertilizer at 30DAS and at harvest (132.6 cm^2 and 310.2 cm^2 during 30 DAS and at harvest respectively) (Table 1). Significant differences with respect to dry matter production and its accumulation in different plant parts was observed due to application of RDN with different sources. Application of 100% RDN through fertilizer recorded significantly higher total dry matter accumulation of radish both at 30DAS and at harvest as compared to N_2 and N_3. (1.50g and 6.35g plant $^{-1}$ respectively) (Table1). Radish yield and yield attributes was affected significantly by application of nitrogen by different sources. Application of 100% RDN through fertilizer recorded significantly higher root yield (11812 kg ha^{-1}) and yield attributing parameters such as root length per plant (13.2cm), root diameter (2.98cm) as compared to other treatments. (Table2). Significant increase in yield parameters and yield was possibly due to availability of more nutrients when compared to other treatments. The integrated application of organic manures and inorganic fertilizers could not improve the yield when compared to application of recommended doses of fertilizer, which lead to increased photosynthates accumulation and higher biomass production. N, P and K contents in root and shoot of radish were significantly maximum in treatment applied with 100% recommended dose of nitrogen through fertilizer. Higher N, P and K concentration in treatment recommended dose of nitrogen was mainly due to the inorganic fertilizers improved the nutrient status of soli, owing to greater absorption of nutrients due adequate of availability of N, P_2O_5 and K_2O [1]

ECONOMICS

Among soil moisture conservation practices with protective irrigation, treatment moisture conservation furrow + protective irrigation + mulching resulted in higher net returns and benefit : cost (B:C) ratio as compared to other treatments. Application of 100% of recommended dose of nitrogen through fertilizer recorded the highest net returns and benefit : cost (B:C) ratio (Table 4).

It could be concluded that, radish being a short duration crop (40-45 days), the entire amount of nutrients was available within the cropping period and it was possible only when it was supplied with inorganic fertilizer and it was proved in this experiment. Higher root yield and net income in radish could be realized by adopting soil moisture conservation practices with protective irrigation along with application of recommended dose of inorganic fertilizers. Rain water harvesting is a technology of runoff farming which is feasible in dryland areas. The technology of rain water harvesting is highly location specific By recycling the runoff water collected in the farm pond certainly improves crop, soil and water productivity under scarce resource conditions.

Table 1. Effect of nitrogen sources and moisture conservation practices with protective irrigation on growth parameters of radish at different growth stages.

Treatments	Plant height(cm)		Number of leaves		Leaf area(cm^2)		Total dry matter accumulation(g/plant)	
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
M_1: Moisture Conservation furrow+ Protective Irrigation + Mulching	18.0	29.5	6.4	9.6	142.4	338.9	1.8	7.3
M_2: Moisture Conservation furrow + Protective Irrigation	16.6	26.2	5.8	8.7	132.4	319.8	1.5	6.3
M_3: Control	13.6	20.3	4.3	7.0	110.6	240.2	0.9	4.2
CD (P=0.05)	0.6	1.4	0.2	0.7	3.3	18.8	0.1	0.5
CV (%)	2.7	4.1	3.0	6.4	2.0	4.9	6.4	7.0
N_1: Recommended dose of fertilizers	16.6	26.6	5.8	8.8	132.6	310.2	1.5	6.4
N_2: 50% Reco. N thro' Farm Yard Manure + 50% N through fertilizer and Reco. P_2O_5 and K_2O	16.0	25.2	5.4	8.4	127.6	298.2	1.4	6.0
N_3:50% Reco. N thro' glyricidia manure+50% N thro' fertilizer and Reco. P_2O_5 and K_2O	15.6	24.4	5.3	8.2	125.3	290.5	1.3	5.7
CD (P=0.05)	0.4	0.5	0.2	0.4	3.9	9.1	0.09	0.4
CV (%)	2.6	1.7	2.4	4.5	3.0	3.0	6.7	7.1

Table 2. Effect of nitrogen sources and moisture conservation practices with protective irrigation on yield parameters and yield of radish at different growth stages.

Treatments	Root length (cm)	Root diameter (cm)	Root yield (kg/ha)
M_1: Moisture Conservation furrow +Protective Irrigation+ Mulching	15.5	3.43	14287
M_2: Moisture Conservation furrow + Protective Irrigation	13.4	3.01	11792
M_3: Control	8.6	1.90	6090
CD (P=0.05)	**0.76**	**0.10**	**2418.9**
CV (%)	**4.6**	**2.8**	**17.2**
N_1: Recommended dose of fertilizers	13.2	2.98	11812
N_2:50% recommended N through Farm Yard Manure+50% N through fertilizer and Recommended P_2O_5 and K_2O	12.4	2.75	10513
N_3:50% recommended N through glyricidia manure+50% N through fertilizer and Recommended P_2O_5 and K_2O	11.8	2.61	9845
CD (P=0.05)	**0.60**	**0.16**	**1051.8**
CV%	**4.7**	**5.5**	**9.5**

Table 3: Effect of nitrogen sources and moisture conservation practices with protective irrigation on N, P and K content of root and shoot of radish at harvest.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Root	Shoot	Root	Shoot	Root	Shoot
M_1: Moisture Conservation furrow + Protective Irrigation + Mulching	1.42	2.19	0.39	0.35	3.53	3.18
M_2: Moisture Conservation furrow + Protective Irrigation	1.37	2.13	0.35	0.32	3.40	3.04
M_3: Control	1.25	2.02	0.23	0.25	3.09	2.74
CD (P=0.05)	0.04	0.05	0.03	0.02	0.12	1.03
CV (%)	3.0	7.8	15.0	16.5	5.5	0.05
N_1: Recommended dose of fertilizers	1.37	2.14	0.35	0.32	3.4	3.05
N_2:50% Recommended N thro' Farm Yard Manure +50% N thro' fertilizer and Recommended P_2O_5 and K_2O	1.34	2.11	0.32	0.30	3.33	2.98
N_3:50% Recommended N thro' glyricidia manure + 50% N thro' fertilizer and Reco. P_2O_5 and K_2O	1.33	2.09	0.31	0.29	3.29	2.94
CD (P=0.05)	0.02	0.02	0.01	0.012	0.047	0.040
CV (%)	0.7	3.2	3.1	2.6	1.4	1.2

Table 4: Effect of nitrogen sources and moisture conservation practices with protective irrigation on economics of radish.

Treatments	Cost of cultivation (Rs.)	Net returns (Rs.)	B: C ratio
$\mathbf{M_1}$**:** Moisture Conservation furrow+ Protective Irrigation+ Mulching	19982	51457	2.57
$\mathbf{M_2}$**:** Moisture Conservation furrow + Protective Irrigation	18481	40477	2.19
$\mathbf{M_3}$**:** Control	18022	12432	0.69
$\mathbf{N_1}$**:** Recommended dose of fertilizers	17632	41428	2.35
$\mathbf{N_2}$**:**50% Reco. N thro' Farm Yard Manure + 50% N thro' fertilizer and Reco. P_2O_5 and K_2O	20941	31626	1.51
$\mathbf{N_3}$**:**50% Reco. N thro' glyricidia manure + 50% N thro' fertilizer and Reco.P_2O_5 and K_2O	17912	31312	1.75

Price of Radish: Rs. 5/- per kg

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