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Effect of *in-situ* moisture conservation methods on growth and yield of pigeonpea in semiarid conditions of Karnataka

S.A. Biradar, Vivek S. Devarnavadagi, Shivalingappa Hotkar and B. Mallappa

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See end of the Paper for authors' affiliation

Correspondence to :

S.A. Biradar
ICAR-Krishi Vigyan Kendra, Hitnalli Farm, **Vijayapur (Karnataka) India**
Email: vivdev2@gmail.com, kvkbijapur@gmail.com

ABSTRACT : Broad bed furrow (BBF) and tied ridging (TR) were evaluated in ten farmer's fields during rainy-winter (*Kharif-Rabi*) seasons of 2018-19 and 2019-20 in Vertisols at Vijayapur, Karnataka. Adopting BBF and tied ridging increased the grain yield by 24.64, 11.68 per cent for 2018-19 and 26.27, 11.21 per cent for 2019-20, respectively. The increase in grain yield indicates that BBF is effective for in-situ rainwater conservation and improving profile soil moisture in Vertisols. However BBF technology conserved higher soil moisture as compared to tied ridging and farmer's practice over the entire crop growth period. Higher gross and net returns with greater B:C ratio was observed with layout of farmers fields with BBF technology.

KEY WORDS : Pigeonpea, Broad bed furrow, Vertisols

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Global level, climate change impact has become a major concern and its impact felt in rainfed areas of Semi-Arid Tropical (SAT) region. In regional context, climate change has contributed to unpredictable or erratic rainfall pattern resulting in greater runoff, soil loss, including shift in sowing and harvesting period of crops thus leading to reduced yield of *Rabi* crops cultivated on residual soil moisture. Nearly 73 per cent of the cropland in the world and about 60 per cent of the cultivated area in India is rainfed and it contributes to 40 per cent of total food production. In India about 93 per cent of sorghum, 94 per cent of pearlmillet, 79 per cent of corn, 87 per cent of pulses, 76 per cent oilseeds and 64 per cent of cotton cultivated in drylands and it also foster major livestock production systems (Singh *et al.*, 2007 and Somasundaram *et al.*, 2014). Rainfed/dryland eco-system in India is characterized both by erratic rainfall and frequent droughts. In such situations, *in-situ* rainwater conservation can sustain crop yields in the region especially in the drought years with uneven rainfall distribution (Patil and Sheelavantar, 2004; Rao *et al.*, 2007 and Venkateswarlu and Shankar, 2009).

Rainwater conservation is a critical factor in stabilizing and stepping up of crop yields in drylands. Land configuration like broad bed and furrow (BBF) can increase infiltration of rainwater and thus helps to improve moisture storage in soil profile (Mathukia and Khanpura, 2009). In arid and semi-arid regions, high evaporative demand cause moisture loss from upper two to three inches layer of the loose and pulverized soil very rapidly and thus could not become available to plant. The BBF resulted in lower runoff and soil loss with higher yield, monetary returns and water use efficiency compared with flat bed (Jadhav *et al.*, 2008 and Suryawanshi *et* *al.*, 2008). Devi *et al.* (1991) observed that BBF resulted in larger water storage and higher seed yield of castor than the other tillage treatments. Singh *et al.* (1999) and Nagavallemma *et al.* (2005) reported that land treatments (raised sunken bed system, ridges and furrows, broad bed and furrows) increased *in-situ* soil moisture conservation, minimized runoff, and soil erosion and increased the yield of principal crops grown in the region.

To increase the soil moisture availability to the agricultural crops and to increase the infiltration and percolation of rain water into the root profile, the *in-situ* moisture conservation techniques are recommended. While considerable importance has been given to increase the productivity of the irrigated lands under green revolution, sufficient attention has not been given to increase the productivity of the rainfed areas. The moisture is the key limiting factor in the rainfed farming and rainfall is the only source of water for these vast stretch of lands. It is necessary to harvest maximum rain water and to adopt methods to maximize the retention of the available moisture. Hence in rainfed areas, the *in-situ* rainwater harvesting through BBF assumes greater priority.

■ METHODOLOGY

A field demonstration was carried out during the rainy (*Kharif*) season of 2018-19 and 2019-20 under northern dryzone of Karnataka at Tajpur village of Vijayapur district (situated at 16° 46' N latitude, 75° 32' E longitude and at an altitude of about 629 m above mean sea level). The demonstration was carried out with 3 treatments (T_1=Farmers practice, T_2= Broad bed furrow and T_3= Tied ridging) and 10 replications under Randomized Complete Block Design in the farmer's field. The land was brought to optimum tilth by ploughing twice with tractor drawn mould board plough. Deep ploughing with mould board plough followed by 3-4 harrowing during summer helps to conserve rain water in deeper soil layers for a longer period. The soils of demonstration field for evaluating pigeonpea crop under different moisture conservation practices was deep clay soil with pH 7.8, available organic carbon 0.42 per cent, available N, P and K were 252.3, 38.7 and 482.3 kg ha^{-1}, respectively. Land preparation started with medium tillage during second fortnight of March 2018 in all the ten selected farmer's fields. After first rains in the first week of June, all fields were harrowed and in the second week broad beds were prepared of 120 cm wide and 20 cm height of bed. Also each furrow spacing was maintained upto 45 cm apart. Tied ridges were formed by blocking the furrows manually with earthen bunds at 1.5 m intervals and also the created micro catchment basins retain surface runoff in the field.

Sowing of pigeonpea was done on 21st June 2018 and 18th June 2019. Seeds of pigeonpea variety (TS 3R) were sown in line using *Pora* method (dropping the seeds in furrow behind the plough) of sowing and seed rate of pigeonpea was 10 kg ha^{-1} in all two cropping systems. Weeds were controlled through one hoeing at 20 days after sowing and one manual weeding. The recommended rate of N (25 kg ha^{-1}) and P_2O_5 (50 kg ha^{-1}) was applied at sowing. The soil moisture content (15 cm deep) for all the treatments was taken for every 30 days interval time. Crop was harvested from 15th January 2018 and 25th January 2019 at physiological maturity. Five randomly selected plants from three sites in each treatment were harvested. Standard procedures were used to measure the yield attributes and yield parameters of pigeonpea. Variables were analyzed and least significance difference (LSD) test was carried out for analyzed mean square errors using Web Based Agricultural Statistics software Package (WASP 2.0). Significance and non-significance difference between treatments was derived through procedure provides for a single LSD value (Gomez and Gomez, 1984). Correlation studies among the yield components of pigeonpea was done using XLSTAT package.

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Available soil moisture dynamics:

Among the different *in situ* soil moisture conservation techniques, broad bed furrow conserved 5.5, 9.3, 13.3, 32.2 13.9 and 22.4 per cent more soil moisture over farmers practice at seedling, flowering and maturity stages of pigeonpea for 2018 and 14.5, 29.0, 28.9, 18.8, 27.5 and 49.3 for 2019, respectively (Table 1). Irrespective of tied ridges, broad bed furrow treatments recorded higher soil moisture mainly due to greater infiltration by reduced runoff and subsequent

Table 1 : Soil moisture percentage (15 cm depth) at different stages for pigeonpea

Treatments	Before sowing		30 DAS		60 DAS		90 DAS		120 DAS		150 DAS		At Harvest	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Farmers practice (T_1)	24.0	19.3	25.2	18.6	19.4	22.0	21.8	23.8	15.2	18.6	18.0	13.8	12.5	7.3
Broad bed furrow (T_2)	24.0	19.4	26.6	21.3	21.2	28.4	24.7	30.7	20.1	22.1	20.5	17.6	15.3	10.9
Tied ridging (T_3)	24.0	19.4	25.9	20.0	20.3	26.5	25.6	27.6	19.9	20.4	21.6	15.2	16.0	8.6

arresting the evaporation of the infiltrated water and reduced weed growth apparently contributes to soil moisture gains. Tied ridges have conserved the rain water through reduced runoff loss, increased infiltration over the farmer's practice of moisture conservation. Tied ridges recorded more soil moisture than the farmer's practice because of its still local conservation by the ties, which is an improvement over traditional farmer's practice where the rainfall could be lost as runoff. The farmer's practice of moisture conservation registered lower soil moisture during the cropping period mainly because of sealing of surface by falling rains resulted in more runoff loss and less infiltration. The soil moisture availability, crop yield and cost benefit ratio were higher for Broad bed and furrow system than the flat bed system (Maurya and Devadattam, 1987).

Growth parameters:

There is increase and difference in plant height was observed over the entire crop growth period between the treatments due to maintenance of soil moisture status in the profile. The highest plant height was observed in broad bed furrow treatment which is on par with tied ridging (Table 2). Broad bed furrow significantly increased the plant height by 21.5 per cent over the farmer's practice treatment. The increased growth in broad bed furrow treatment was due to higher moisture conservation and better growth of plants. Wani *et al.* (2005) observed the performance of the broad bed and furrow system on chickpea which was consistently superior to the traditional system in reducing annual run-off, soil loss, and peak run-off rate. They remarked when rainfall was very low and moisture conservation was crucial, the broad bed and furrow system conserved most of the annual rainfall.

Yield and economics:

The difference in yield between the treatments was due to enough soil moisture availability at 15 cm depth of soil during the entire crop period. Among the different soil moisture conservation treatments the highest yield was registered in broad bed furrow treatment 10.67 q/ha (2018) and 11.15 q/ha (2019) which is on-par with tied ridging treatment 9.56 q/ha (2018) and 9.82 q/ha (2019), respectively (Table 3). Broad bed furrow increased the yield by 24.64 per cent (2018) and 26.27 per cent (2019) over the farmer's practice treatment. The yield in BBF farming was 6.5 per cent more than

Table 2 : Plant height (cm) under different moisture conservation treatments for Pigeonpea

Treatments	45 DAS		90 DAS		135 DAS		At Harvest	
	2018	2019	2018	2019	2018	2019	2018	2019
Farmers practice (T_1)	32.6	41.3	71.5	80.5	134.6	133.0	139.0	137.2
Broad bed furrow (T_2)	46.3	52.0	85.6	92.3	158.9	154.8	161.5	166.7
Tied ridging (T_3)	41.0	49.2	82.4	87.4	151.4	150.4	153.1	154.6
S.E. ±	1.88	1.10	1.21	1.73	2.58	1.49	2.87	4.15
C.D. (P=0.05)	5.61	3.15	3.45	5.15	7.65	4.47	8.63	12.47

Table 3 : Yield and economics of Pigeonpea under moisture conservation treatments

Treatments	Yield (kg ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2018	2019	2018	2019	2018	2019	2018	2019
Farmers practice (T_1)	8.56	8.83	52216	53265	28296	29325	2.18	2.03
Broad bed furrow (T_2)	10.67	11.15	65099	67215	40979	42598	2.70	2.85
Tied ridging (T_3)	9.56	9.82	59316	61275	32396	31850	2.25	2.33
S.E. ±	0.43	0.49	1932.6	1983	2864.5	3588.2	0.17	0.20
C.D. (P=0.05)	1.23	1.44	5794	5946	8589	10763	0.48	0.57

that of traditional method due to conservation of soil moisture through the broad bed furrows (Ejieji and Adeniran, 2010).

We found higher gross returns of Rs. 65099 ha^{-1} (2018) and Rs. 67215 ha^{-1} (2019) with more net returns of Rs. 40979 ha^{-1} (2018) and Rs. 42598 ha^{-1} (2019) was observed in broad bed furrow treatment which is on par with tied ridging treatment. Gross returns, net returns and B:C ratio were higher by 24.67, 44.82 and 23.85 per cent for 2018 and 26.18, 45.26 and 40.39 per cent for 2019 over farmer's practice respectively (Table 3). Sharda and Juyal (2007) in their study conducted in Garhwal district, India, a watershed was treated with various water harvesting and soil conservation measures. Consequently, paddy and wheat yields increased by 1.65 t/ha and 1.93 t/ha, respectively. These measures considerably reduced runoff and soil loss from 42.0 to 0.7 per cent and 11.0 to 2.7 t/ha, respectively with higher B:C ratio and net returns.

Conclusion :

To achieve better crop production and yields in rainfed agriculture it is necessary to adopt *in situ* soil moisture conservation techniques. Farmer's field studies conducted during rainy (*Kharif*) seasons of 2018 and 2019 to evaluate the performance of BBF indicate that layout of farmer's fields with BBF during rainy season (June-July) conserves rainwater *in situ* and improves the soil moisture availability in the profile thus helps in early sowing and higher moisture availability during entire growth period which produces greater pigeonpea yields. Further layout of farmer's field with BBF produces greater pigeonpea yield, gross returns, net returns and B:C ratio over farmers practice. In conclusion, it is advised to adopt BBF to conserve rainwater *in situ* for ensuring sustainable pigeonpea productivity.

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Authors' affiliations:
Vivek S. Devarnavadagi, Shivalingappa Hotkar and B. Mallappa, ICAR-Krishi Vigyan Kendra, Hitnalli Farm, **Vijayapur (Karnataka) India**

REFERENCES

Devi, M.U., Santaiah, V., Rao, S.R., Rao, A.P. and Rao, M.S. (1991). Effect of conservation tillage practices and nitrogen levels on moisture and residual nitrogen in Alfisol under rainfed castor. *J. Oilseeds Res.,*. **8(1):** 40-45.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons Inc., New York, USA., pp: 13-175.

Ejieji, C.J. and Adeniran, K.A. (2010). Effects of water and fertilizer stress on the yield, fresh and dry matter production of grain Amaranth (*Amaranthus cruentus*). *Aust. J. Agric. Engg.,* **1**(1) : 18-24.

Jadhav, S.B., Tekale, D., Pawar, S.N. and Kalbande, S.R. (2008). Comparison of ICRISAT and conventional methods of groundnut cultivation under sprinkler irrigation. *Internat. J. Agric. Sci*., **4** : 646-648.

Mathukia, R.K. and Khanpara, V.D. (2009). Effect of *in-situ* moisture conservation and zinc fertilization on soil properties and productivity of castor (*Ricinus communis* L.). *Indian J. Dryland Agric. Res. & Dev.,* **24** (2): 94-95.

Maurya, N.L. and Devadattam, D.S.K. (1987). Proc. 23rd annual conven. *Indian Society of Agricultural Engineers*, Jabalpur, India, 9-11 March, pp. 77-85.

Nagavallemma, K.P., Wani, S.P., Reddy, M.S. and Pathak, P. (2005). Effect of landform and soil depth on productivity of soybean-based cropping systems and erosion losses in Vertic Inceptisols. *Indian J. Soil Conservation,* **33** (2): 132–136.

Patil, S.L. and Sheelavantar, M.N. (2004). Effect of cultural practices on soil properties, moisture conservation and grain yield of winter sorghum (*Sorghum bicolar* L. Moench) in Semi Arid Tropics of India. *Agric. Water Manage.*, **64** : 49–67.

Rao, C.S., Steiner, J.L. and Mayeux, H.S. (2007). The Role of World's Agricultural Lands for Future Food Security in India, In Book on Challenges and Strategies for Dryland Agriculture (Ed. Barbarick, K.A. and Co-Ed. Rao, C.S and John Ryan), pp. 1–10.

Sharda, V.N. and Juyal, G.P. (2007). Rainwater harvesting, groundwater recharge and efficient use in high rainfall areas. In: *Ensuring Water and Environment for Prosperity and Posterity Souvenir*. 10th Inter-Regional Conference on Water and Environment (ENVIROWAT 2007), 17–20, October, pp. 59–70.

Singh, H.P., Sharma, K.D., Subba Reddy, G. and Sharma, K.L. (2007). Dryland Agriculture in India, In Book on Challenges and Strategies for Dryland Agriculture (Ed. Barbarick, K.A. and Co-Ed. Rao, C.S. and John Ryan), pp. 67–92.

Singh, M.V. (1999). Current status of micro and secondary nutrients deficiencies and crop response in different agro-ecological regions. *Fertilizer News,* **44** (4): 63-82.

Singh, P., Alagarswamy, C., Pathak, P., Wani, S.P., Hoogenboom, G. and Virmani, S.M. (1999). Soybean- chickpea rotation on Vcrticlnceptisols I. Effect of soil depth and landform on light interception, water balance and crop yields. *Field Crops Res*., **63**: 211-224.

Somasundaram, J., Lakaria, B.L., Saha, R., Sinha, N.K., Jha, P., Chaudhary, R.S., Singh, R.K., Manadal, D., Hati, K.M.,Ramesh, K., Vassanda, C., Biswas, A.K., Dey, P., Sammi Reddy, K. and Subba Rao, A. (2014). Management of stressed soils of dryland agriculture in semi-arid tropics-A review. *Indian J. Soil Conserv*., **42** : 178–187.

Suryawanshi, M. W., Jadhav, G. S., Jadhav, P. D. and Jagtap, P. B. (2008). Influence of land layouts and irrigation schedules on yield and water-yield response function of groundnut. *J. Soils & Crops*, **18** : 112-116.

Venkateswarlu, B. and Shanker, A.K. (2009). Climate change and agriculture: adaptation and mitigation strategies. *Indian J. Agron.,* **54** : 226–230.

Wani, S.P., Pathak, P., Sachan, R.C. and Pande, S. (2005). Conservation tillage for enhancing productivity and protecting environment: ICRISAT experience. Conservation Agriculture-Status and Prospects, pp 176–90. Abrol, I P., Gupta, R. K. and Malik, R.K. (Eds). Centre for Advancement of Sustainable Agriculture, National Agriculture Science Centre Complex, New Delhi. *Indian J. Soil Conservation,* **33**(2): 132–6

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