

Research article**EVALUATION OF KANGKONG (*Ipomoea aquatica* L.) GENOTYPE, A POTENTIAL GREEN LEAFY VEGETABLE IN SUMMER SEASON AT KHAJURA, BANKE, NEPAL**

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ABSTRACT

Kangkong (*Ipomoea aquatica* L.) belongs to the plant family Convolvulaceae. A set of varietal trial was conducted in Directorate of Agricultural Research Khajura, Banke, Nepal with three genotypes; HRDKAN001 (Cambodian), HRDKAN002 (Thaipalungo as check variety) and HRDKAN003 (Bangladeshi); which were collected through National Horticulture Research Centre, Khumaltar. The objectives of this experiment were to select high yielding genotypes for green leaf production during summer season. The experiments were carried out in two consecutive years, April 2017 and 2018 and laid out in Randomized completely block design with seven replications in open field condition. The spacing was maintained 50 cm row to row and 30 cm within the row in each year. Plants were fertilized with 200:150:120 kg NPK and 20 tons farm-yard manure per hectare. Data were recorded on vegetative growth, disease response, vegetative yield, qualitative parameter and consumer's preference. From the result of experiment, HRDKAN001 and HRDKAN002 were found to be higher yielding and showed good cooking quality and these genotypes were selected for the further evaluation at Khajura and similar agro-ecological conditions of Nepal.

Keywords: Experiment, Kangkong, parameter, quality, yield

INTRODUCTION

Kangkong (*Ipomoea aquatica* L.) belongs to the plant family Convolvulaceae, a moving glory family. The plant is commonly known as aquatica morning glory, Chinese water spinach, kangkong, morning glory, swamp cabbage, swamp morning glory, water convolvulus, water spinach, aquatic sweet potato, etc. Kangkong is a fast growing, vine-like plant that spreads along the ground or water surface, and is reluctant to climb. It is a close relative to sweetpotato but is grown for its succulent growing tips. There are two types of kangkong, upland type (*Ipomoea reptans*), more common throughout the Pacific and adapted to moist soils and lowland and aquatic kangkong (*Ipomoea aquatica*) which is adapted to flooded conditions (ACIAR, Fact sheet no.6, 2010). Water spinach is a vascular semi-aquatic herbaceous perennial plant belonging to Convolvulaceae (USDA, 2005). It has a hollow and viny stem, grows prostrate or floating, and roots coming from the nodes that penetrate the soil. Water spinach is native to the tropics and subtropics of Southeast Asia, Southern China and India (Gothberg et al., 2005; Chen et al., 1991).

Upland kangkong can grow to a wide range of climatic and soil conditions but requires relatively high soil moisture for optimum growth and yield. Soils having high organic matter are more preferred. It produces higher yields in the lowland humid tropics under stable high temperature and short day length. Temperature between 25-30°C is ideal for higher yields. It can be grown throughout the year if winter is not extreme. Water spinach has no relationship with common spinach but is closely related to sweet potato (*Ipomea batatas*) (www.plants.usda.gov, 2015). It can be propagating from cuttings or seed. Its stems are 2–3 meters (7–10 ft) or more long, rooting at the nodes, and they are hollow and can float (Shrestha & Shrestha, 2020). Leaves are flat, and vary in shape depending on variety, from heart-shaped to long, narrow and arrow-shaped. Narrow leaves are 1-2.5 cm wide and 20-30 cm long. Broad leaves are upto 5 cm wide and 15-25 cm long. The flowers are trumpet-shaped, 3–5 cm (1–2 in) in diameter, and usually white in colour with a mauve centre (Shrestha & Shrestha, 2020).

Ipomoea aquatica a commonly grown green leafy vegetable is a rich source of vitamins, minerals, proteins, fibers, carotenes and flavonoids with many health benefits (Prasad et al., 2008). Kangkong is one of the popular vegetables that is promoted to grow in the island due to its good nutritive value, antioxidant properties, high fiber content and many other health related benefits (Hongfei et al., 2011; Gupta et al., 2005;

Kala &Prakash, 2004; Faruq et al., 2002; Ogle et al., 2001).

In Ayurveda (the traditional medicine), it is reported that oral administration of *I. aquatica* leaves cures diseases such as jaundice, nervous debility. The plant is also used for the treatment of liver diseases, constipations (Samuelsson et al.,1992) diabetes, abscesses, mental illness, nose bleeds and high blood pressure, anthelmintic, central nervous system depression (CNS) depressant, antiepileptic, hypolipidemic effects antimicrobial and anti-inflammatory. In Nepal, during summer season the availability of green leafy vegetables are very low. The price of green vegetable in this period is too much higher. Generally cultivated leafy vegetables are winter season crops and some are available only in rainy season. Some wild types of kangkong are available in water bodies of Terai but they are not cultivable. Such terrestrial genotypes of kangkung will be alternative for the leafy vegetables which are richest source of vitamins and minerals. Different types/varieties of leafy vegetables have been imported in the country from abroad and thus it is of great opportunities to evaluate, select and recommend the suitable high yielding as well as preferable variety for particular location. Considering the facts, the study was conducted to select the high yielding kangkong genotypes for the climate representing Khajura, Banke and similar locations.

MATERIALS AND METHODS

Three genotypes of kangkong were transplanted at the field of Directorate of Agricultural Research (former Regional Agricultural Research Station), Khajura, Banke, Nepal during April, 2017 and 2018 to evaluate the quality and the yield of these genotypes. The source of seed material was received from National Horticulture Research Center formerly known as Horticulture Research Division of NARC. In the first year, the seedlings were prepared in the month of October 2016 from seed and planting materials were prepared from cuttings from nursery and planted in the month of April. Also in the second year, the planting materials were prepared from seed in the month of October and planted in the month of April with the help of cuttings from the seedlings raised in nurserybed. There were used three genotypes of Kangkong for the trial viz. HRDKAN001(Cambodian), HRDKAN002(Thai Palungo) and HRDKAN003(Bangladeshi) which are named as the materials are originally comes from these countries. The experiment was laid out in randomized complete block design having 7 replications. In the first year of evaluation, the individual plot size was 3m², gross plot area consisting 2m length and 1.5m breadth and in the second year of experiment, the size of plot was 1.5x0.6 (0.9m²) and the spacing was maintained 50 cm row to row and 30 cm within the row in each year. The plot size was different due to the lower seedling number in the second year's experiment. The plants were fertilized with 200:150:120 kg NPK/ha and 20 ton/ha compost. The first harvesting was 38 days after transplanting (DAT) and last date of harvesting was 103 DAT. Harvesting was done five times during the entire growing stage. The observations were recorded regarding cooking quality, plant vigor, plant uniformity, plant height at 30 DAT, no. of branches per plant, leaf length, leaf width and the yield. The data were analyzed by using statistical software R-statistics. Cooking quality and taste was measured by the consumers' response in 1(unacceptable) to 9 (excellent) scale where taste was recorded just after boiled. Plant uniformity and vigor was recorded visually in 1 to 5 scale at the time of 30 DAT where uniformity; unacceptable (1) to excellent (5) scale and vigor; poor (1) to vigorous (5) scale. As insect and disease scoring was done at the time of its symptom appeared in plant that was after 90 days (later stage) in 1 (no any symptom) to 5 (dead) scale.

RESULTS AND DISCUSSION

Leaf characters and stem girth

In 2017, there was no significant difference for the length of leaves, width of leaves, stem girth (Table 1). The longest leaf (15.59 cm) were recorded from the genotype HRDKAN001(Cambodian) followed by genotype HRDKAN002 (12.47 cm) and HRDKAN003 (12 cm). In the year of 2018, the length of leaf was found significantly different among the tested genotypes. The longest leaf(15.6 cm) was recorded in the cultivar HRDKAN002 which was at par with the cultivar HRDKAN001 (15.47 cm) and the shortest length of leaf (12.71 cm) was recorded in cultivar HRDKAN003.

Similarly, the width of leaves was found significantly different among the tested genotypes. The highest width of leaf (5.13 cm) was recorded in the cultivar HRDKAN003 and the lowest width of leaf (4.18

cm) was found for the cultivar HRDKAN001 which was similar with the cultivar HRDKAN002 (4.3 cm).

Table 1. Leaf length, leaf width and stem girth of different genotypes of Kangkong in coordinated varietal trial (CVT) at, Khajura during 2017 and 2018

| Genotypes | Leaf length (cm) | | Leaf width (cm) | | Stem girth | |
|------------|------------------|---------|-----------------|-------|------------|------|
| | 2017 | 2018 | 2017 | 2018 | 2017 | 2018 |
| HRDKAN001 | 15.59a | 15.47a | 3.011ab | 4.18b | 0.82 | - |
| HRDKAN002 | 12.47ab | 15.6a | 3.966a | 4.30b | 0.73 | - |
| HRDKAN003 | 12.00ab | 12.71b | 4.165a | 5.13a | 0.80 | - |
| Grand mean | 13.35 | 14.61 | 3.71 | 4.54 | 0.79 | - |
| SEM± | 0.464 | 0.71 | 0.415 | 0.32 | 0.09 | - |
| LSD (0.05) | 1.012 | 0.98*** | 0.903 | 0.65* | 0.20 | - |
| CV (%) | 6.5 | 5.76 | 20.9 | 12.47 | 21.9 | - |

Means within the column followed by the same letter are not significant different at 5 % level of significance by DMRT. *, * * and *** = Significant at 0.05, 0.01 and <0.001 levels, respectively

Plant height

In 2018, the plant height at 30 DAT was found non significant for the tested genotypes. The highest plant height was recorded for the cultivar HRDKAN001(35.5 cm) followed by HRDKAN003 (31.62cm) and HRDKAN002(29.74 cm).

Table 2. Yield and yield attributing parameters of Kangkong genotypes grown at Khajura, Banke in 2017 and 2018

| Genotypes | Plant height at 30 DAT (cm) | | No. of branches per plant (30 DAT) | | Yield (t ha ⁻¹) | |
|---------------------|-----------------------------|--------|------------------------------------|-------|-----------------------------|--------|
| | 2017 | 2018 | 2017 | 2018 | 2017 | 2018 |
| HRDKAN001 | - | 35.50 | - | 3.22 | 60.30 | 82.36 |
| HRDKAN002 | - | 29.74 | - | 3.68 | 58.18 | 95.87 |
| HRDKAN003 | - | 31.62 | - | 4.05 | 53.05 | 87.42 |
| Grand Mean | - | 32.29 | - | 3.65 | 57.2 | 88.55 |
| SEM(±) | - | 109.11 | - | 0.99 | 10.10 | 233.21 |
| LSD _{0.05} | - | ns | - | ns | 22 | ns |
| CV% | - | 32.34 | - | 27.30 | 33 | 17.24 |

Means within the column followed by the same letter are not significant different at 5 % level of significance by DMRT.

Number of branches per plant

In 2018, the number of branches per plant at 30 DAT was found non-significant for the tested genotypes. However, more number of branches per plant was recorded for the cultivar HRDKAN003 (4.05) followed by HRDKAN002 (3.68) and HRDKAN001 (3.22).

Yield

In the both years, non-significant difference was found for the yield. In 2017, the highest yield (60.3 t ha⁻¹) was recorded in the genotype HRDKAN001 followed by HRDKAN002 (58.18 t ha⁻¹) and HRDKAN003 (53.05 t ha⁻¹) and in the year of 2018, the highest (95.87 t/ha) yield was from cultivar HRDKAN002 and the lowest (82.36 t/ha) yield was obtained from cultivar HRDKAN001 while cultivar HRDKAN003 produced 87.42 t ha⁻¹.

Plant vigor and plant uniformity

In 2018, plant vigor at 30 DAT was found non-significant among the tested genotypes. The cultivar HRDKAN001 and HRDKAN002 had recorded 3 score (Medium, intermediate or normal growth) according to 1-5 rating hedonic scale for plant vigor while the cultivar HRDKAN003 had 2.85 (Medium, intermediate or normal growth) rating for plant vigor. Plant uniformity at 30 DAT were found non-significant among the tested genotypes. The cultivar HRDKAN001 and HRDKAN002 have recorded 3(fair) according to 1-5 points rating scale for plant uniformity while the cultivar HRDKAN003(Bangladeshi) has 2.85 (fair) for plant uniformity.

Table 3. Plant vigor, Plant uniformity, Disease and insect scoring and overall eating quality of Kangkong genotypes, Khajura, Banke, 2018

| Genotypes | Plant vigor (1-5) ^x at 30 DAP | Plant uniformity (1-5) ^x at 30 DAP | Disease scoring (0-5) ^y | Insect Scoring (0-5) ^y | Overall eating quality (1-9) |
|-----------|--|---|------------------------------------|-----------------------------------|------------------------------|
| HRDKAN001 | 3.00 | 3.00 | 1(mild) | 3(mild) | 9(excellent) |
| HRDKAN002 | 3.00 | 3.00 | 1(mild) | 3(mild) | 7(good) |
| HRDKAN003 | 2.85 | 2.85 | 1(mild) | 3(mild) | 3(fair) |

^x 1:unacceptable, 5:excellent

^y 0:none, 5:extreme

Disease and insect infestation

In 2018, the severity of disease and insect infestation were recorded same for the all tested genotypes. Disease scoring was 1(mild) and insect scoring was recorded as 3 (medium) for the all genotypes in 0-5 scale. No any disease was observed at the early stage up to 90 DAT (Table 1). Insect damage was very little and was only by leaf eating caterpillar in early stage but due to frequent harvest, it was controlled.

Overall eating quality

The result of organoleptic taste conducted in the research station revealed that there is variation in taste and the texture of the leaves. The cultivar HRDKAN001 got 9 ranking because of good taste and soft texture after cook as compared to other genotypes. The cultivar HRDKAN003 got 3 ranking due to slightly sour taste and hardy after cook.

The taste and tenderness varies among the tested genotypes. The consumers of Khajura prefer HRDKAN001 followed by HRDKAN002. Shrestha and Shrestha (2020) reported that Consumer's response showed that HRDKAN002 had been selected due to its good appearance, taste and tenderness. Even though HRDKAN003 had excellent appearance and tenderness, taste of HRDKAN002 was preferred by consumers. The problem of disease and insect were not severe during the growth stage so it gave bumper yield. Pests and diseases do not usually cause problems (ACIAR,Fact sheet 8, Kangkong,2014). Leaf eating insects such as grasshoppers and some caterpillars are occasional pests that may become a problem in drier weather. Leaf miner and mealybug can cause reduced growth and malformed leaves. Healthy planting material and good growing conditions can help reduce the occurrence and impact of these pests. The difference in the leaf length among the genotypes is due to genetic makeup of the genotypes. The variation on the length and size of leaf was supported by Shrestha and Shrestha (2020). The longest leaf length (20.5 cm) was obtained in cv. HRDKAN001 followed by HRDKAN002 (20.4 cm) whereas the wider leaf was noticed in HRDKAN003 (7.1 cm) followed by HRDKAN002 (6.6 cm). Sharma (1994) had also mentioned the highly variable leaf shape. Chauhan (2016) also reported that the leaf length ranged from 5.58 (IGWS-17) to 10.69 cm (IGWS-2) and from small to medium size group. Leaf width ranged from 1.69 (IGWS-23) to 5.90 cm (IGWS-2). The highest yield was obtained from the HRDKAN002. The similar result was obtained from Shrestha and Shrestha (2020) who stated that HRDKAN002 which had average consumable branch weight of 18.4 g, yielded 89 branches weighing 1620 g per plant, and 107.6 ton/ha along with negligible insect pest and disease damage. Yamaguchi (1990) reported that Kangkong is easy to grow, has a high yield and considered as nutritious. The marketable yield of Kangkong under protected condition was 55 t/ha and 31.5 t/ha in open

field condition. (ACIAR, Farmer fact sheet on Kangkong field production in Philipinnes).

First harvesting was recorded at 38 DAT which was supported by the Factsheet on kangkong in Philipinnes where the first harvest of kangkong is done at 3 weeks from seeding and subsequent harvesting of new shoots is done at 2-3 weeks interval depending on the stand of the crop.

CONCLUSION

From the results obtained from the two year's experiment, Kangkong can be easily grown during summer and rainy season without use of chemical pesticide. Genotypes HRDKAN001 and HRDKAN002 which had the highest yield and good cooking quality and almost not damaged by the insect pest and disease were promising to cultivate in the Khajura, Banke and similar growing conditions of Nepal. Further validation will be required for the consistent performance of the genotypes.

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